Water Banking and Water Marketing in Select Western States

Case Study Review: Colorado, Idaho, & Nebraska

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1. EXECUTIVE SUMMARY

Providing sustainable access to adequate water supplies presents a critical and confounding challenge throughout the American west. Water is a uniquely fungible resource, necessary for basic human survival, fundamental to economic activity, and foundational for habitat conservation. In the twenty-first century, many states are confronted by regions of critical shortfall of water supply due to extensive appropriations and anthropogenic climate change, while limited native supplies restrict the total available supply. Water banking and the creation of water markets – mechanisms for the voluntary transaction of existing water rights to more economically efficient uses – have emerged as a useful policy tool for public and private stakeholders to address the looming supply gap. This report will examine the context and practice of water banking institutions in Idaho, Colorado, and Nebraska.

Water reallocation strategies such as water banking and water marketing are instruments for transferring scarce water resources for new beneficial uses. Mechanisms for voluntary water transfers are important for future economic growth and maintaining instream resources in areas where water is fully appropriated and demand for consumptive use grows. In Washington, a water bank is defined as a water management tool allowing for the transfer of existing rights between willing sellers and buyers, whereas water marketing is often defined more generally as an institutional framework governing the exchange of water rights. Since 2009, Washington state has created 25 water banks for the voluntary transfer of existing rights between sellers and buyers. The majority of the established banks are located in the Yakima River Basin, but banks are also found on the mainstem of the Columbia River, Dungeness River Basin, and Walla Walla River Basin.

As part of an effort to evaluate policy decisions around water banking and to improve water management throughout Washington, the Washington State Department of Ecology Water Resources Program (Ecology) has commissioned this study to assess administrative involvement in water banking and water marketing in other Western states. *Water Banking and Water Marketing in Select Western States* provides a review and analysis of water banking and water marketing, including case studies of water reallocation strategies in Colorado, Idaho, and Nebraska. Case studies are selected based on similar state-level legal frameworks and the presence of active water banks and/or water markets in each state. Additionally, these case studies offer varied user characteristics (e.g. agricultural and municipal participants) and management structures (public, private, or quasi-governmental). Each case study examines relevant policies and statutes, outlines existing and proposed water banks and water markets, and discusses the relevant market mechanisms utilized in the operation of water banks and water markets.

We summarize pertinent findings from each case study across three key themes: adjudication and clearly defined property rights, collaborative governance and stakeholder engagement, and institutional design considerations.

1. **Clearly defined property rights and the importance of adjudication**: The Colorado and Idaho case studies both highlight the importance of clearly defined property rights, particularly the importance of adjudication, to the success of water banking and water marketing programs in each case. All interviewees with the Idaho Department of Water Resources (IDWR) acknowledge the importance of adjudication, even in basins that are not closed to new water rights permits. Interviewees note that adjudication helps to streamline water resource administration such as the management of delivery calls or adherence to minimum streamflows. Similarly, in Colorado the well-defined and protected nature of water rights achieved through adjudication helps to enable a well-functioning and active market for water rights throughout the state.

2. **Collaborative governance and stakeholder engagement:** All three case study states include positive examples of methods of inclusive governance. The success of these programs suggests the necessity of developing social capital assets for successful water rights management in order to discourage litigation and promote valuable information-sharing. In Colorado, much of the water supply planning and policy is done by collaborative roundtable entities composed of right holders and other stakeholders within each basin, including creating Basin Implementation Plans (BIPs) which identify water supply gaps and propose strategies to meet those needs. In addition to planning for future supply shortages, these collaborative roundtables have generated notable secondary effects including information-sharing among historically antagonistic stakeholders which has improved market information and price signaling within water rights markets. In addition to this information sharing, the roundtables have helped to improve public engagement around water rights issues and increase trust in state oversight and decision making. Similar improvements to stakeholder engagement and trust are promoted in Nebraska through the use of Natural Resources Districts (NRDs) for groundwater management. The local nature of groundwater management in Nebraska allows for flexibility in creating rules and regulations that are tailored to local hydro-geological and socio-political conditions. NRDs are governed by locally elected boards, affording residents more control over their own groundwater resources. Boards commonly include local groundwater irrigators which gives NRDs more credibility with other farmers in the community, allowing NRDs to impose regulations and enforcements that may otherwise be politically unpopular or even infeasible. Lastly, in Idaho, stakeholder engagement and the involvement of key public sector officials was critical in the achievement of the

highly consequential settlement agreements. Notably, Idaho's Governor and Attorney General were principals in the negotiation of the Swan Falls Agreement in 1984 and the Speaker of the House was the mediator of the first Surface Water Coalition - Idaho Ground Water Appropriations, Inc. (SWC-IGWA) Settlement Agreement in 2015.

3. **Institutional Design Considerations:** The case studies outline unique water banking and marketing institutions that help to facilitate the success of water banking and water marketing programs in each state. In Idaho, the introduction of fees allowed for additional resources to accommodate growing demand while having no discernable impact on demand in subsequent years. In Colorado, the district water courts generate extensive market information while limiting the use of the judiciary as a lawmaking body. Finally, in Nebraska the details of regulatory systems are vital in achieving the water management goals of NRDs. The success of these programs has been mixed and largely depends on the specific transfer rules and regulations that have been set up by the NRD, emphasizing the importance of structural regulatory details.

4. **Other Water Management Strategies:** The Idaho and Colorado case studies demonstrate alternative water management strategies that are used to create functioning markets. Alternatives include Colorado's water court system and shareholder water bank, as well as Idaho's settlement agreements. In Idaho, there is a lot of optimism that the Surface Water Coalition - Idaho Ground Water Appropriations, Inc. (SWC-IGWA) Settlement Agreement can be a long-term solution to the persistent problems in Idaho's Eastern Snake Plain Aquifer (ESPA). To date, junior groundwater pumps have made substantive reductions to water consumption while the Idaho Water Resource Board (IWRB) has exceeded its aquifer recharge targets for three consecutive years. In Colorado, all applications for new appropriations, change of water right use or place, water right transfers, and curtailment calls must be submitted to the water court for evaluation and approval. Moreover, third parties seeking to claim injury due to new or altered appropriations must submit official objections during the evaluation process, dramatically limiting the scope and expense of water rights-related litigation. Finally, major transbasin diversion operations in Colorado disburse water supplies through a shareholder process. This system works best in cases where the controlling entity is able to own return flows from shareholder use (as is the case in transbasin diversions) so that place of use can be freely changed within the disbursement region. As a result of this system, the underlying water right generating the water bank is not subject to any alteration through the operation of the bank or changes in the composition of water consumers.

2. GLOSSARY OF TERMS

Acre-feet: a unit of volume equal to exactly 43,560 cubic feet, or roughly 325,851 U.S. gallons.

Acre-inch: a unit of volume equal to exactly 3,630 cubic feet, or roughly 27,154 U.S. gallons.

Allocation: a limit on the amount of groundwater that a well owner can pump (measured in acre-inches) over a certain period of time.

Certified irrigated acre: an acre of land with a demonstrable history of irrigation use. All transfers of groundwater rights in Nebraska are tied to certified irrigated acres.

Conjunctive administration: legal and hydrologic integration of surface water and groundwater rights into a single administrative framework in hydraulically connected areas.

Consumptive use: the amount of water that does not return to its source after it has been diverted and put to beneficial use.

Correlative rights: a legal framework for water rights whereby water users have an equal right to groundwater regardless of the date of issuance of water rights. Under this framework, users must limit their use of a common resource to a reasonable share, and all users must limit their use in times of scarcity; also known as “share and share alike”.

Decree: an official document issued by the court defining the priority, amount, use, timing and location of a water right.

Delivery call (call): a request made by the holder of a senior-priority surface or groundwater right for water which the person is entitled to; such a call will force junior water rights holders to cease or diminish their diversions.

Floating township: a set of 36 contiguous blocks of land made up of six by six mile squares used by the Upper Republican and South Platte Natural Resources Districts in Nebraska to limit the distance that groundwater rights can be transferred.

Lease: to convey by contract a water right to a water bank.

Pooling: combining allocations for groundwater pumping, or, the joint operation of tracts of certified irrigated acres.

Prior appropriation doctrine: the first person to take a quantity of water from a water source for "beneficial use" has the right to continue to use that quantity of water for that purpose. First users have rights senior to those issued later—"first in time, first in right."

Priority date: the date when a water right was established.

Reasonable use doctrine: a legal framework for water rights that gives landowners the right to to use the water associated with their land provided that the use is "reasonable", meaning that it doesn't prevent other landowners from using the resource.

Rent: to convey by contract a water right from a water bank.

Saturated thickness: the vertical thickness of an aquifer where the spaces between gravel, sand, or silt (pores) are filled with water.

Smart market: a water banking method that uses an algorithm that takes a jurisdiction's rules and regulations into account to match buyers and sellers. Smart markets have been implemented in three Natural Resources Districts in Nebraska as well as in Washington's Yakima Basin.

Stream depletion factor: a method of measuring the impact of groundwater pumping on a surface water system in a particular area based on factors including but not limited to hydraulic conductivity, soil type, soil permeability, and proximity to a river or stream; used by Nebraska Natural Resources Districts to determine water right transfer ratios.

Subordination: voluntary relinquishment of a water right's priority to selected or all junior water rights.

Water bank: a formal water market exchange institution.

3. INTRODUCTION

3.1 Project Description

Water reallocation strategies such as water banking and water marketing are instruments for transferring scarce water resources for new beneficial uses. Mechanisms for voluntary water transfers are important for future economic growth and maintaining instream resources in areas where water is fully appropriated and demand for consumptive use grows. As part of an effort to evaluate policy decisions around water banking and to improve water management throughout Washington, the Washington State Department of Ecology Water Resources Program (Ecology) has commissioned this study to assess administrative involvement in water banking and water marketing in other Western states. *Water Banking and Water Marketing in Select Western States* provides a review and analysis of water banking and water marketing, including case studies of water reallocation strategies in Colorado, Idaho, and Nebraska. Each case study examines relevant policies and statutes, outlines existing and proposed water banks and water markets, and discusses the relevant market mechanisms utilized in the operation of water banks and water markets. Finally, this report highlights pertinent findings from each case to inform Ecology's future direction in water management.

3.2 Research Question

This report explores the following questions to assess water banking and water marketing in other Western states:

- What role do other state governments play in the development and management of water banks?
- What market-based tools for water reallocation are employed in other Western states?

In addition to these questions, several sub-questions are explored including:

- What are some of the self-identified strengths and weaknesses of other states' approaches?
- What statutory, regulatory, and financial mechanisms are used to support water banking in other states?
- How do market mechanisms (e.g., fee structures) promote effective and functioning markets?
- How are water banks used (i.e., agricultural, residential, drought response, or other water uses)?

The remaining chapters of this report are organized as follows:

- In *Chapter 4: Research Methodology*, we provide an overview of our research methodology including a review of our case study selection process, stakeholder interviews, and additional literature searches.
- In *Chapter 5: Water Banking and Marketing in Western States*, we begin with a brief overview of water management and water banking in Washington as context before providing an overview of water banking and water marketing derived from the literature.
- In *Chapter 6: Colorado Case Study*, we examine relevant statutory and regulatory considerations, outline existing and proposed water banks and water markets, and discuss the relevant market mechanisms used in the operation of water banks and water markets in Colorado.
- In *Chapter 7: Idaho Case Study*, we examine relevant statutory and regulatory considerations, outline existing and proposed water banks and water markets, and discuss the relevant market mechanisms used in the operation of water banks and water markets in Idaho.
- In *Chapter 8: Nebraska Case Study*, we examine relevant statutory and regulatory considerations, outline existing and proposed water banks and water markets, and discuss the relevant market mechanisms used in the operation of water banks and water markets in Nebraska.
- In *Chapter 9: Findings*, we outline important findings from each case study and identify findings and themes that cut across all case study states.
- In *Chapter 10: Conclusion*, we provide a brief conclusion of the purpose and outcomes of this report.
- In *Appendix 11.1: Stakeholder Interviews*, we provide a list of individuals and organizations interviewed for the case studies included in this report.
- In *Appendix 11.2: Interview Questions*, we provide a list of guiding questions used in our stakeholder interviews.

4. RESEARCH METHODOLOGY

4.1 Case Study Criteria and Selection

All Western states with a prior appropriation system of water rights governance were considered for case study selection. This included Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, and Wyoming. Preliminary research was conducted on all states to obtain a high-level overview of the context around water banking in each state, and its similarity to that of Washington. This included information on:

- State-level legal frameworks, namely whether a state's legal framework includes mechanisms to protect instream flows;
- The presence of active water banks or markets, including information on the volume of trading activity in each state (i.e. water bank participation rates);
- Management type, or whether a water bank or market is publicly run, quasi-governmental or privately run, and;
- User characteristics, or whether a water bank or market was used primarily for agricultural or domestic purposes.

Table 4.1 outlines this overview for each state below.

The pool of candidate case studies was narrowed to those with a similar state-level legal framework to that of Washington (i.e., instream flow rule and conjunctive management of groundwater and surface water), and states with active banks (i.e., recent activity and substantial participation rates) after an initial review. From this winnowed pool, case studies were selected to maximize variation across two primary criteria: user characteristics and management type. Washington's legal framework, including recent case law, create a unique set of challenges that are not exactly replicated in any other Western state. Therefore, a focus on a diversity of user characteristics (i.e., both agricultural and domestic uses) and management type (i.e., both publicly- and privately-run banks) in case study selection was pursued to ensure that cases were applicable to contexts throughout the state. California and Texas were excluded from consideration due to the unique legal frameworks and characteristics of water banks and water markets in these states. Water banks and markets in each case are discussed within their legal and regulatory context to allow for analysis of applicability to Washington. Based on these criteria, the final selected case studies include Colorado, Idaho and Nebraska.

Table 4.1 Legal and Water Banking Characteristics of Western Prior Appropriation States

	Mechanisms to protect instream flows	Active water bank(s) or market(s)	Management Type	User Characteristics
Arizona	✓	✓	public	I, M
California	✓	✓	public and private	A, M
Colorado	✓	✓	public and private	A, I, M
Idaho	✓	✓	public	A, I, M
Kansas		✓	private not-for-profit	A
Montana	✓	✓	private	A
Nebraska	✓	✓	public and private	A
Nevada		✓	public	M
New Mexico	✓	✓	public	A
North Dakota		✓	public	A
Oklahoma				
Oregon	✓	✓	public	A, I, M
South Dakota				
Texas		✓	public and private	A, I, M
Utah	✓			
Wyoming				

A = agriculture, I = industrial, M = municipal

4.2 Literature Review

We conducted a literature review to obtain information specific to state-level case studies as well as general, overarching information related to water banking. The literature review included both published and grey literature, such as government reports pertaining to water banking, relevant legal documents (e.g., statutes, case law, etc.), reports, public agency documents and websites, and white papers. Searches were conducted in Google, Hein Online, Factiva, and Proquest's Agricultural & Environmental Science database. All documents were reviewed for definitions of water banking, legal framework of water rights, water transfer laws, bank design, and market mechanisms used for water trading. Following the review of all relevant documents, results were analyzed to identify unique characteristics of each case study state, shared trends across cases, and the specific context (legal and physical) relevant to each state.

4.3 Stakeholder Interviews

We conducted semi-structured phone interviews with stakeholders in each of the case study states, as well as individuals involved with water banking in Western states more broadly. We began our interviews with contacts suggested by Ecology, as well as primary actors identified in our preliminary research. We then conducted additional interviews with contacts suggested during those initial interviews. In total, we conducted 28 interviews; seven with individuals in Colorado, nine with individuals in Idaho, eleven with individuals in Nebraska, and one with an individual involved with water banking more broadly. See Appendix 11.2 for a list of individuals contacted and interviewed, and Appendix 11.3 for a list of interview questions.

5. WATER BANKING & MARKETING IN WESTERN STATES

5.1 Context: Prior Appropriation Water Management and Water Banking in Washington State

In Washington, water is considered a common property resource subject to the prior appropriation doctrine of "first-in-time, first-in-right."[1] Individuals seeking to divert public water file an application to develop a water right with Ecology.[2] Prior to issuing a water right permit for a proposed use, Ecology must verify that the use meets a four-part test:

- Water must be available (both physically and legally)
- Water must be used beneficially
- Water use must not be detrimental to the public interest
- Water use must not impair existing rights[3]

Older (senior) rights hold priority over newer (junior) rights regardless of their physical location within the watershed. In the event of shortage, usage may be curtailed in reverse order of priority such that senior right-holders receive their full allotments before junior rights-holders receive any allocation. Senior rights-holders whose allotments have been impaired by upstream junior diversion may also petition a "call" for curtailment of the junior right.

To maintain a prior appropriation water right, right-holders are required to put their allotment to beneficial use on a regular basis. Failure to demonstrate beneficial use (without sufficient cause) over a five-year period, known as the "use it or lose it" statute, will subject that right to relinquishment.[4] In Washington, beneficial use of a water right is defined as "use of water for domestic, stock watering, industrial, commercial, agricultural, irrigation, hydroelectric power production, mining, fish and wildlife maintenance and enhancement, recreational, and thermal power production purposes, and preservation of environmental and aesthetic values, and all other uses compatible with the enjoyment of the public waters of the state."[5]

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[1] Washington State Department of Ecology, "Water Rights."
[2] Washington state's groundwater permit exemption allows for small uses of groundwater without a water right permit. Exempt uses fall into four categories: domestic use of less than 5,000 gallons per day; industrial uses of less than 5,000 gallons per day; irrigation of a lawn or non-commercial garden, a half-acre or less in size; stock water.
[3] Washington State Department of Ecology, "Water Rights."
[4] Washington State Legislature, RCW 90.14.140.
[5] Washington State Legislature, WAC 173-500-050(4).

A water right is required for any amount of surface water used for any purpose in the state of Washington, and for many groundwater uses. However, permit exemptions are available for the following groundwater uses[6]:

- Providing water for livestock (no gallon per day limit or annual use restriction).
- Watering a non-commercial lawn or garden one-half acre in size or less.
- An industrial purpose (limited to 5,000 gallons per day)
- Providing water for single or group domestic uses (limited to 5,000 gallons per day).[7]

In Washington, a water bank is considered a water management tool allowing for the transfer of existing rights between willing sellers and buyers, who will put that water to a new beneficial use.[8] Water banks are established in consultation with Ecology and generally involve a water right, or multiple water rights, being conveyed to Ecology and held in the Trust Water Rights Program, a program which allows Ecology to hold a water right for future use, maintains the right's original priority date, and protects that right from relinquishment.[9] Since 2009, 25 water banks have been created. The majority are located in the Yakima River Basin, but also utilized in the Columbia River mainstem, Dungeness River Basin, and Walla Walla River Basin.[10] Public banks are operated directly by a public agency, while quasi-public banks are jointly managed by a public entity and an NGO.

The Trust Water Rights Program also provides the flexibility to enhance streamflows for fish and wildlife habitat, as well for mitigating for future out of stream uses.[11] This program element is relevant in Washington as state law requires that sufficient water be kept in streams and rivers to protect fish, wildlife, recreation, aesthetics, water quality, and navigation. One way that this is achieved is through setting instream flow rules.[12] Instream flow rules do not impact more senior water rights but serve to protect stream flows from additional consumptive diversions or withdrawals. Currently in Washington there are 27 basins with a state instream flow rule, three basins with a federal instream flow rule, and two basins with proposed instream flow rules; the remaining 30 basins have no state, federal or proposed instream flow rule.[13]

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[6] Washington State Department of Ecology, "Groundwater permit exemption."
[7] Washington State Department of Ecology, "Water Rights."
[8] Washington State Department of Ecology, "Water Banks."
[9] Washington State Department of Ecology, "Water Rights."
[10] Washington State Department of Ecology, "Tracking Water Banks."
[11] Washington State Department of Ecology, "Trust Water Rights Program."
[12] Washington State Department of Ecology, "Protecting Stream Flows."
[13] Washington State Department of Ecology, "Instream Flow Rule Status Map."

Water management policy in Washington is further driven by an evolving legal framework. The following four legal cases generated a rigorous regulatory framework for water allocations:

- *Postema v. Pollution Control Hearings Board* (Supreme Court of the State of Washington 2000) defined a *de minimis* standard for judging impairment of existing rights (notably including instream flow rights). In practice, this restricted groundwater access in watersheds with unmet instream flows even if those impacts are neither physically measurable nor significant.[14]
- *Swinomish Indian Tribal Community v. Ecology* (Supreme Court of the State of Washington 2013) rejected the application of overriding consideration of the public interest (OCPI) to justify water use that impairs existing instream flows, and stated that OCPI is a narrow exception requiring extraordinary circumstances.[15]
- *Foster v. Ecology* (Supreme Court of the State of Washington 2015) rejected the use of out-of-kind mitigation of streamflow impairments. As a result, impairments must be in-kind (water-for-water), in-place, and in-time, even for *de minimis* impairments.[16]
- *Hirst, Futurewise, et al. v. Whatcom County* (Supreme Court of the State of Washington 2016) in practice means that county authorities must evaluate new permit-exempt groundwater withdrawals for *de minimis* impairments in watersheds with instream flow impairments on a case-by-case basis.[17]

5.2 Definitions of Water Banking, Water Marketing, and Water Transfers

There are a variety of terms related to systems of market-based water reallocation and those terms are used in slightly different ways throughout the literature. The four most commonly used terms are "water bank", "water market", and "water transfer" or "transaction". The Western Governors' Association (2012) defines a water transfer as "a voluntary agreement that results in a temporary or permanent change in the type, time or place of use of water and/or a water right."[18] They more narrowly define a water bank as "a mechanism in which a water right holder can 'deposit' a water use entitlement with a private or public entity (the bank) that can make the entitlement available for lease on a temporary basis by another person for use in another location."[19] Conversely, O'Donnell and Colby (2010) define a water bank more broadly as "an

[14] Postema v. Pollution Control Hr'gs Bd., 142 Wn.2d 68, 77, 11 P.3d (2000).
[15] Swinomish Indian Tribal Community v. Department of Ecology, 178 Wn.2d 571, 311 P.3d 6 (2013).
[16] *Foster v. Dep't of Ecology*, 184 Wn.2d 465, 362 P.3d 959 (2015).
[17] Whatcom County, Hirst (Eric) v. W. Wash. Growth Mgmt. Hr'gs Bd., No. 91475-3 (Wash. Oct. 6, 2016).
[18] Western Governors' Association and Western States Water Council, "Water Transfers in the West."
[19] Western Governors' Association and Western States Water Council, "Water Transfers in the West."

institutional mechanism designed to facilitate transfers of water on a temporary, intermittent or permanent basis through voluntary exchange."[20] Other authors use "water market" to encompass a similar definition. Aylward et al. (2016) define water market as "a set of rules, set by the appropriate authority, to govern the exchange of water rights between willing buyers and sellers."[21] The authors mention water banks in defining a water marketplace, which they term "a specific mechanism developed as a place where market participants can obtain information and/or conduct transactions." They note that examples of this water marketplace include water banks or exchanges, water auctions and smart markets.[22] Throughout the following section we will use specific terminology utilized by the authors cited, and most often use "water transfer" or "transaction" to mean changes to water use and/or water rights and "water market" to mean the enabling framework that allows for the exchange of water rights. The term "water bank" will most often be used to denote the deposit and lease structure described by the Western Governors' Association.

5.3 Goals, Benefits and Drawbacks of Market-Based Water Reallocation

Water transfers, water marketing, and water banking are tools designed to achieve a variety of goals and are associated with various benefits. As physical water scarcity increases along with demand due to the changing climate, population growth, and changes in economies, water transfers will become an increasingly important tool for water management, in conjunction with other supply and demand management strategies. Water transfers allow for the reallocation of water use in an economically efficient way, from water use that is wasteful or relatively low value from an economic perspective to relatively high value uses by bringing together willing buyers and sellers, thus increasing the benefit of scarce water resources on aggregate.[23] From the users' perspective, water transfers are a tool that increases flexibility and allows for the reduction of risk and uncertainty surrounding water resource management in times of scarcity; water transfers can be used to adjust to both long-term economic drivers and short-term supply fluctuations.[24] The literature notes that market-based reallocation strategies are preferred by

[20] Bonnie Colby and Michael O'Donnell, "Water banks: a tool for enhancing water supply reliability."
[21] Aylward et al., "Political economy of water markets;" Aylward et al., "Healthy water markets: a conceptual framework."
[22] Ibid.
[23] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States;" Clifford et al., "Analysis of water banking in other western states;" Western Governors' Association and Western States Water Council, "Water Transfers in the West."
[24] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."

many due to their expected economic efficiency and socio-political benefits associated with the voluntary and user directed nature of water transfers.[25]

Aylward et al. (2016) argue that water markets help to achieve effective management of water supply and demand in a cost-effective and timely manner, and in a way that can provide opportunities for environmental conservation and social inclusion.[26] The Nature Conservancy (2016) outlines many noteworthy benefits of water markets that echo the efficacy, efficiency and environmental and social sustainability described by Aylward et al. (2016). They argue that water markets promote water savings through providing a stimulus for reduced consumptive use; monetizing the value of water allows users to sell or lease unneeded water. Water markets increase water availability and improve community flexibility; the ability to transfer water between uses allows for flexibility as conditions and preferences change and allows water managers to avoid creating a new supply. Additionally, the Nature Conservancy argues that the trading of water rights allows for the improvement of productivity and efficiency by discouraging wasteful or economically low-value uses and reallocating rights to more productive uses. Lastly, water markets provide opportunities for environmental conservation when rights are purchased in the market and reallocated for environmental purposes.[27] Goals of water transfers, water marketing and water banking programs include creating reliability in the water supply, especially in dry years, creating greater water reliability, promoting environmental conservation, and ensuring future water supply for a variety of needs.[28]

There are however several potential drawbacks to market-based systems of water reallocation. Water is at once both a public and private resource. The public good characteristics of water create the potential for inefficient allocation of the resource; market based water reallocation is only effective for uses that can be monetized and for those able to participate in the market.[29] Additionally, there is the potential for third party impacts resulting from the use of water banks and water markets. This is especially true where water is banked in lieu of agricultural production. The transfer of water away from agricultural uses can have localized negative impacts on rural economies; dryland crops are generally less productive and profitable than

[25] Aylward et al., "Healthy water markets," 16.
[26] Aylward et al., "Healthy water markets," 20.
[27] The Nature Conservancy, "Water share: using water markets and impact investment to drive sustainability."
[28] Clifford et al., "Analysis of water banking in other western states."
[29] Aylward et al., "Healthy water markets," 15.

irrigated crops.[30] Generally, questions still remain as to the extent to which market-based systems of water reallocation are equitable and effectively protect environmental resources.[31]

5.4 Market Mechanisms & Types of Transactions

Most water transfers that occur in Western states are between agricultural users and occur through informal and decentralized processes; these transfers often occur within a local entity such as an irrigation district or canal company and involve a reporting and approval process that is simple and internal to that entity.[32] However, there are a variety of common market structures utilized in more formal settings. The most common structures include bulletin boards or clearinghouses, fixed price, water supply options, and auctions. Key components of each structure are outlined in Table 5.1 below.

Water transfers can take a variety of forms including leasing, permanent sales, pooling, or other arrangements.[33] Leasing involves the right to use water allocated to a seller's water right during a specific period of time.[34] Leases vary in length and can range from a portion of a season to a multi-year contract. Once the contract period has expired the water right reverts back to the lessor.[35] Some Western states have systems in place which prioritize leases, as they have fewer lasting impacts than a permanent transfer, such as streamlined approval processes which expedite leases for specific programs (e.g., drought).[36] One example of this is Oregon's instream leasing program which expedites processing of leases for instream flow purposes; approvals are granted without an injury review.[37]

Permanent transfers occur when all of a water right or a portion of a water right is sold, in perpetuity, in exchange for payment. This transaction typically involves review and approval by the relevant regulatory agency and involves a formal record of the sale.[38] The Western Governors' Association in their report *Water Transfers in the West: Projects, trends and leading practices in voluntary water trading* note that where transfers occur between agricultural and

[30] Bonnie Colby and Michael O'Donnell, "Water banks: a tool for enhancing water supply reliability;" Western Governors' Association and Western States Water Council, "Water Transfers in the West."
[31] Aylward et al., "Healthy water markets."
[32] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."
[33] Ibid.
[34] Aylward et al., "Healthy water markets."
[35] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."
[36] Western Governors' Association and Western States Water Council, "Water Transfers in the West."
[37] Aylward et al., "Political economy of water markets."
[38] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."

Table 5.1 Common Market Structures for Water Reallocation

Bulletin Board	• Simplest and most common structure; exists in many jurisdictions • Willing buyers and sellers self-identify as interested in trading • Can be physical (e.g., actual bulletin board) or electronic (i.e., a website) • Typically maintained by the regulatory agency	e.g. Central Kansas Water Bank Association (Kansas)
Electronic Clearinghouse	• Buyers and sellers are matched to each other directly • Can either be privately run, or run by the regulatory agency • More sophisticated, but not as common as bulletin boards	e.g. Twin Platte Natural Resources District (Nebraska)
Fixed Price	• Market clearing price is predetermined by the entity operating the water bank or market; all water users trade at the same price • Can help foster a sense of fairness • Lack of market-based pricing structure can fail to incentivize activity (e.g., in dry years) • May be necessary to include price tiers due to differing value of water entitlements (i.e., due to priority date)	e.g. Semitropic Groundwater Storage Bank (California)
Auction	• Can either be through an open-cry (i.e., yelled out) or sealed-bid process • Most common forms are single-sided (only offers or bids at one time) or double-sided (simultaneously) and can be run by either a public or private entity (whomever operates the bank or market) • Create rich price information through continued updating of market values; prices revealed through offers and bids	e.g. 2001 Klamath Basin Pilot Water Bank (Oregon)
Water Supply Option	• Participants buy or sell the option to supply or purchase water in the future • Contracts dictate details such as price, quantity, timing, location, etc.	e.g. Metropolitan Water District of Southern California (California)
Contingent Contract	• Buyers and sellers enter into contracts that are only executed under certain conditions (i.e., low supply) • Transaction costs are often higher than for non-contingent contract • Minimizes unnecessary transfers	e.g. Metropolitan Water District—Palo Verde Irrigation District (California)

urban uses that a drawback of permanent transfers is the retirement of agriculture and its impacts to rural communities.[39] Pooling is a common practice of agricultural water transfers where water rights are aggregated and reallocated across fields. In situations where the fields belong to multiple producers, there is typically compensation for how water is allocated across fields.[40]

5.5 Necessary Conditions for Water Banking

It is generally accepted that the primary necessary conditions for a water market include scarcity, well-defined and secure property rights, and the ability to trade those rights. In the context of water markets, scarcity includes both the concepts of physical scarcity and legal scarcity. Physical scarcity refers to the resource availability, or, the question of whether there is sufficient water available to meet all needs. Legal scarcity relates more to the legal limits on the use of water, achieved either through a limited number of water rights allocated, or regulation limiting the annual allocation of water.[41] In addition to these three primary factors, enabling conditions include a system for water measurement and accounting, and a system for enforcing allocations and regulations.[42] Aylward et al. (2016) state that in addition to these generally accepted conditions, flexible property rights and transferability of rights are necessary conditions for healthy water markets. Transferability in this context goes beyond the ability to trade water rights (i.e., between users for the same type of use) to include the ability to transfer rights to new uses (e.g. from an agricultural to an environmental use); this is particularly important for fulfilling the goals of environmental conservation and restoration. However, the authors note that when transferring uses, regulatory protections and capacities are important in ensuring environmental and social uses are not eroded.[43] Flexibility refers to the ability to adapt water rights, water transfer programs, and water management strategies more broadly to changing circumstances. This may include increasing water scarcity due to the changing climate, or increased conflict over competing human or ecosystem uses.[44]

[39] Western Governors' Association and Western States Water Council, "Water Transfers in the West."
[40] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."
[41] Aylward et al., "Healthy water markets."
[42] Aylward et al., "Political economy of water markets."
[43] Some states, including Washington, note that strict impairment standards and regulations make finding water banking solutions significantly more difficult and serve to limit water banking activity and the potential of water banking as a solution to water supply challenges.
[44] Aylward et al., "Healthy water markets."

5.6 Role of Government

The policy of the Western States Water Council states that "Western states have primary authority and responsibility for the appropriation, allocation, development, conservation and protection of water resources, both groundwater and surface water, including protection of water quality, instream flows and aquatic species."[45] This responsibility includes the regulation and administration of water, including defining and enforcing property rights to ensure and promote properly functioning water markets.[46] Monitoring and enforcement in Western states often includes spot checks, energy or flow meters, remote sensing, aerial photography or other mechanisms to ensure that the timing and quantities associated with a specific transfer is as intended.[47]

Young & Brozovic (2019) note that for agricultural water transfers in particular, most occur at a local or regional scale, what they term "intra-district transfers" as they most often occur within irrigation districts, groundwater management districts, or individual canal companies. They note that the approval and reporting processes for these transfers are often relatively simple, and that in the majority of states it is not required for these intra-district transfers to be reported to the state regulatory entity. In contrast, they note that transfers occurring outside of a district often require state approval and reporting, which carries additional costs.[48]

5.7 Key Issues in Water Transfers

Articles reviewed discuss several challenges and key issues related to market-based systems for allocating scarce water resources. Many of these issues are related to market imperfections such as barriers to entry or imperfect information. Others relate to the appropriateness of markets for allocating water, which is at once both a public and private good. Several articles talk about the challenges associated with quantifying and regulating water use. Often the water use is not well quantified or defined, resulting in back and forth between water users and regulators, which can create a costly and time consuming transfer process, or serve as a disincentive to engage in the market.[49] The high costs associated with a transfer process can include those associated with estimating a water right holder's water use, including those costs associated with hiring

[45] Western Governors' Association and Western States Water Council, "Water Transfers in the West," 5.
[46] Ibid.
[47] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."
[48] Ibid.
[49] Aylward et al., "Political economy of water markets."

engineers, attorneys or other professionals.[50] Young & Brozovic (2019) note that particularly for agricultural producers, the high transaction costs associated with water transfers can present a high barrier and could result in markets in which only the wealthy producers and consumers of water rights are able to participate.[51] Aylward et al. (2016) also cite high offer prices and unduly high transaction costs as two factors which may lead to a reluctance to participate in water markets.[52] However, they also cite simple fear of engaging in water markets or unwillingness to engage in water markets, such as fear of social or political backlash from engaging in controversial buy and dry transactions. From the public sector's perspective this could manifest itself as pursuing more expensive water supply options, such as reuse, in lieu of marketing for fear of the socio-political backlash.[53]

General distrust of water markets exist among many stakeholders, including community-centered and environmental groups who may be skeptical of how water markets value social equity and environmental protection.[54] Distrust of water marketing may also exist among agricultural water users who may fear that the mechanism is intended to move water away from agricultural uses to urban or environmental uses.[55] Young & Brozovic (2019) cite a broad misconception among water users that a strong system of water rights (i.e., strong monitoring and enforcement mechanisms) reduces an individual's water security. However, their study found that water security is more threatened by a lack of monitoring and enforcement, and that weaker water rights administrations decrease the value of water rights.[56]

Another concern related to water markets is the potential for unintended third-party impacts, including impacts to agricultural communities. Colby and O'Donnell note that in water bank operations, where water is banked in lieu of agricultural production, there is a possibility for localized impacts to area economies, including a reduction in the number of individuals in the workforce.[57] The Western Governors' Association echoes these concerns, noting that irrigated agriculture tends to draw higher profits than dryland crops; transferring water from irrigated agriculture to other uses could result in a loss of economic activity.[58] These authors suggest considering mitigation funds for third party impacts in the event that water banking or water

[50] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."
[51] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States," 23.
[52] Aylward et al., "Political economy of water markets."
[53] Ibid.
[54] Aylward et al., "Healthy water markets."
[55] Ibid.
[56] Richael Young and Nicholas Brozovic, "Agricultural water transfers in the Western United States."
[57] Bonnie Colby and Michael O'Donnell, "Water banks: a tool for enhancing water supply reliability."
[58] Western Governors' Association and Western States Water Council, "Water Transfers in the West."

marketing programs are instituted in small agricultural communities, or elsewhere third party impacts are anticipated.

Additional concerns regarding water markets include those related to behavior that would result in an increase in overall water use. Two behaviors that Aylward et al. (2016) point to include what they term "permit queuing" and "sleeper rights." Permit queuing as the authors define it involves filing for a water use permit and not immediately providing proof of beneficial use to perfect the right; this is advantageous in locations where the priority date of a water right is the application date. The authors point to Nevada where permit applications themselves are transferable and the place of use can be changed prior to development of the right. They argue that in this case applications serve to hold a place in the priority date "line" and where extensions for proving beneficial use are provided, this process essentially allows for low cost speculation. In most Western states the path to a water right involves filing for a permit and later providing proof of beneficial use to perfect a right. However, the authors argue that it is the lax deadlines to prove rights, and the transferability of unproven permits in the Nevada case, that can amount to speculation. Sleeper rights involve the ability of a water market to motivate those who might otherwise forfeit their water right through non-use, or who have already technically forfeited their water right through non-use, to attempt to resurrect their right in order to participate in a water market.[59] To mitigate for these behaviors, Aylward et al. (2016) argue for a system of forfeiture, however both they and others point to how systems of forfeiture, particularly partial forfeiture, can negatively impact water markets.

In *Political Economy of Water Markets in the Western US*, Aylward et al. (2016) note that fear of exposing water rights to state scrutiny is a commonly cited obstacle to engaging in water marketing among water users. This is due to the possibility that examination of a water right will result in full or partial forfeiture during the required state examination associated with water banking. Partial forfeiture refers to procedures by which a water right holder may lose a portion of that right if it is not used as prescribed.[60] They note that this is of particular concern for water users who may be considering investments in water use efficiency. Squillace and McLeod echo this concern in *Marketing Conserved Water*, noting that water rights based on historical consumptive use provide an incentive for farmers to consume that allotment of water. They argue for narrow water banking programs that focus on transfers of what they term conserved consumptive water, or only the portion of a water right that is no longer consumed after efficiency improvements, such as deficit irrigation, crop switching and rotational fallowing of

[59] Aylward et al., "Political economy of water markets."
[60] Western Governors' Association and Western States Water Council, "Water Transfers in the West."

land; the authors see this as an approach which could help to garner support from and avoid impacts to agricultural communities.[61] Proposed reforms to allow for this include clear rules related to marketing of conserved water including rules related to how water savings will be measured and verified, and whether transfers based on these strategies can be permanent or long-term, or solely temporary.

[61] Mark Squillace and Anthony McLeod, "Marketing conserved water," 46.

6. COLORADO CASE STUDY

The state of Colorado offers a unique blueprint among western states for a statewide private market for water rights, as well as multiple innovative programs for the use of water banking to improve allocative efficiency of water rights at the local and regional levels through governmental and quasi-governmental mechanisms. In this case study, we examine the unique governance structures that have enabled private markets and public water banks, as well as the recent water supply planning reforms that have effectively integrated stakeholders into the water supply planning process.

6.1 Law and Administration

Initial appropriations of water rights began in 1851 during the territorial period, predating the institution of centralized legal and administrative structures. Institutionalized prior appropriation of water rights in Colorado dates to the adoption of the "Colorado Doctrine" by the territorial government during the 1860s.[62] It is further enshrined in law by the 1876 state constitution, which states: "The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied. Priority of appropriation shall give the better right as between those using the water for the same purpose."[63] Statutory definition of the prior appropriation system was refined by the Water Right Determination and Administration Act of 1969 ("1969 Act"), which declared that the state's administrative priority shall be given to "maximize the beneficial use of all the waters of the state."[64] The 1969 Act also defined the state's role in water administration in the following ways:

- Mandated conjunctive management of surface water and tributary groundwater
- Created the state water courts for each major watershed
- Defined adjudication procedures
- Authorized "augmentation" (mitigation of impairments with replacement water)
- Defined rulemaking and enforcement authority of the Division of Water Resources
- Defined administrative procedures for new appropriations, change requests, and augmentation plans

Colorado law distinguishes between tributary and other groundwater sources and administers them separately. Tributary groundwater is defined as groundwater in hydrological continuity with surface flows and its appropriation is subject to the integrated conjunctive management

[62] Colorado Water Conservation Board, "Colorado's Water Plan," 2015. 2.3-2.7.
[63] Colorado Constitution, Article 16, Section 3.
[64] Colorado General Assembly, "Water Right Determination and Administration," CRS 37-92.

system.[65] All groundwater bodies are considered tributary unless they are legally exempted or empirically demonstrated to have no hydrological continuity to surface flows.

Non-tributary groundwater sources are exempted from the priority system and are administered on a case-by-case basis by the Division of Water Resources and the Colorado Ground Water Commission. Some sources may be governed by Colorado's Groundwater Management Act or other statutory mechanisms, but all are subject to Division of Water Resources permitting processes.[66] These include defined non-tributary groundwater (no anticipated impacts on surface flows over a 100-year period), designated groundwater (sources isolated from surface flows considered unavailable to surface appropriation), and Denver Basin groundwater (geographically bounded sources with potential proximity to surface flows allowable under special mitigation plans).[67]

Beneficial uses in Colorado were initially limited to domestic use and resource production such as irrigation, stock, and mining operations. Definitions have expanded over the past century to incorporate other uses, primarily for environmental and recreational benefits. Current beneficial uses in Colorado include:

- Augmentation
- Basin export
- Cumulative recharge
- Commercial
- Domestic
- Evaporative
- Interstate export
- Federal reserved
- Household use
- Irrigation
- Minimum streamflow
- Municipal
- Hydroelectric generation
- Recharge
- Recreation
- Snow production[68]

[65] Colorado Water Conservation Board, "Colorado's Water Plan," 2.4.
[66] Colorado Water Conservation Board, "Colorado's Water Plan," 2.5.
[67] Colorado Foundation for Water Education, "Citizen's Guide to Colorado Water Law, Third Edition," 10-11.
[68] Colorado Foundation for Water Education, "Citizen's Guide to Colorado Water Law, Third Edition," 7.

COLORADO WATER FOR THE 21ST CENTURY ACT

Following extreme droughts during 2002 and 2003, state agencies implemented the Statewide Water Supply Initiative (SWSI) in order to provide a comprehensive assessment of the state's water supply needs and identify threats to their fulfillment. Following the success of the SWSI, the General Assembly enacted the Colorado Water for the 21st Century Act ("21st Century Act") in 2005.[69] Its goal was to provide a comprehensive plan for water supply planning for the entire state in order to prevent similar crises from recurring in the future.

Priorities of the Colorado Water for the 21st Century Act include:

- Maximize the amount of water available for beneficial use in the face of limited supply, changing climatic conditions, and interstate compact obligations
- Promote environmental concerns and compliance with interstate compact obligations
- Promote conservation and storage projects
- Develop funding sources and disbursement mechanisms for water projects
- Promote efficiency and mitigation
- Improve state permitting, monitoring, and enforcement functions
- Expand outreach, education, and public engagement programming[70]

The 21st Century Act created nine basin-wide roundtables as well as an Interbasin Compact Committee (IBCC) in order to mobilize the resources and experience of water consumers in each water management region in the state. Roundtable membership includes stakeholders selected to represent the full diversity of water consumers within each basin, including farmers, ranchers, industry, recreation and tourism interests, local governments, private water suppliers, environmental advocates, and federal agencies. The initial duties of the roundtables generally involved discussion and approval of funding disbursements toward water supply projects; however, the value of these forums for public participation led to an expanding scope of responsibility, and they have developed into critical advisors to the Colorado Water Conservation Board (CWCB) for policy and planning. In 2014, each basin roundtable was empowered to draft its own Basin Implementation Plan (BIP), adapting the resources of the state administration to fit the specific needs of each region. The BIPs provided a critical assessment of anticipated water supply needs and proposed strategies to meet these needs at the basin level.

[69] Colorado General Assembly, "Interbasin Compact," CRS 37-75-101 to 37-75-106.
[70] Colorado Water Conservation Board, "Colorado's Water Plan," xviii-xix.

6.2 State Water Administration

State-level management of water rights and planning is governed by three institutions: the CWCB, the Department of Natural Resources Water Resources Division, and the Colorado Water Courts.

COLORADO WATER COURTS

Water courts are a specialized court system created by the 1969 Act with seven divisions throughout the state.[71] Water judges for each court are appointed by the Colorado Supreme Court and wield authority over all legal processes pertaining to water rights and water use within their district. Each office is staffed by a DWR water engineer appointed by the state engineer, a water referee appointed by the water judge, and a water clerk appointed by the district court.

All applications for water appropriations, water right changes, or water right transfers must be submitted to the water court for approval. All applications are published for public comment by interested parties, who must submit statements of opposition in order to claim injury as a result of the court's decision.

Because the court has full authority over all transfers of water rights within the state, it constitutes the *de facto* water marketplace for exchanges within the prior appropriation system. Colorado has the most active market for formal transfers in the western United States, and its activities are extensively documented online through the Colorado Information Marketplace.[72]

WATER RESOURCES DIVISION

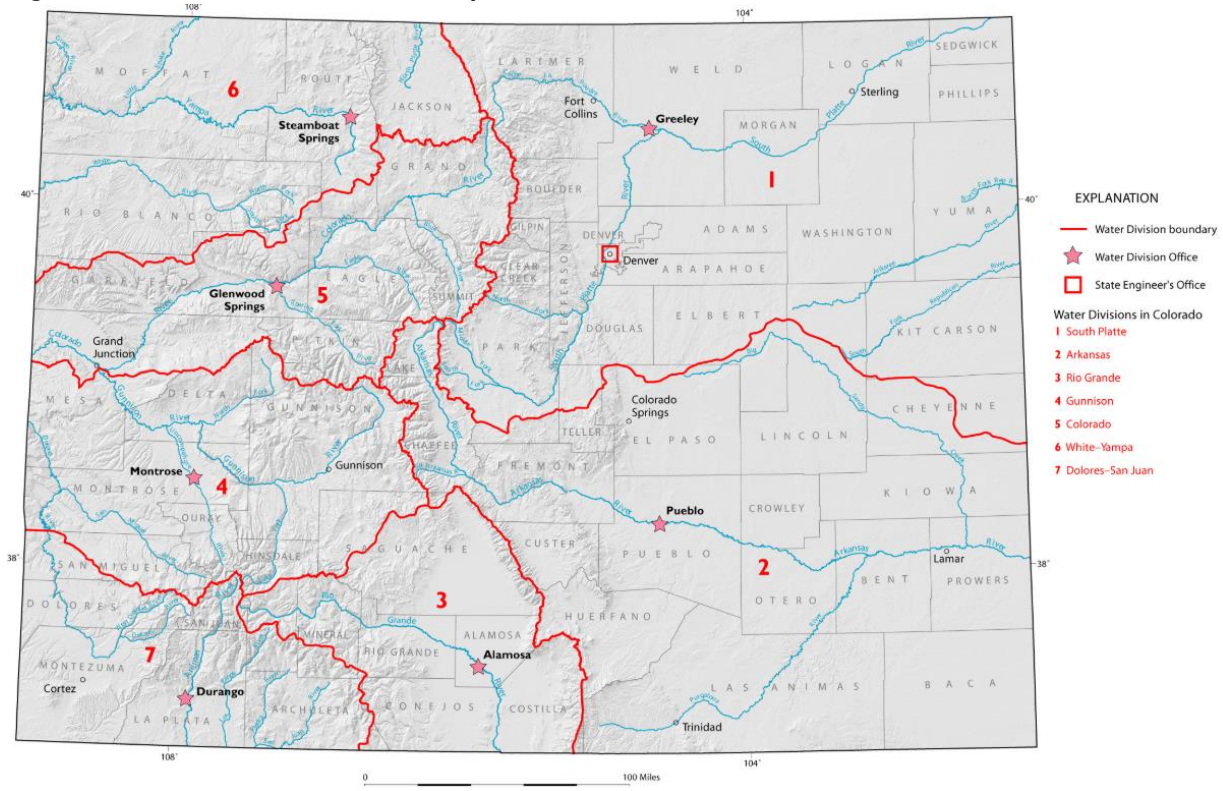
Administration of water rights in Colorado is delegated to the Division of Water Resources (DWR) within the Colorado Department of Natural Resources. The DWR maintains seven regional offices for each of its divisions, corresponding with the major watersheds in the state.

The DWR is also responsible for administering water rights procedures that do not fall under the jurisdiction of the water court; its primary activity in this sphere is the evaluation and issuance of priority-exempt well permits. Other duties prescribed to the DWR include inspecting wells and dams; monitoring and recording hydrological conditions; overseeing physical allocations of

[71] Colorado General Assembly, "Water Divisions - Courts," CRS 37-92-201 to 37-92-204
[72] Western Governors' Association and Western States Water Council, "Water Transfers in the West," 16.

water from available supplies; monitoring and enforcing transbasin and interstate flows; and enforcing water court decrees.

Figure 6.1 Administrative water districts of Colorado



Source: Citizen's Guide to Colorado Water Law

COLORADO WATER CONSERVATION BOARD

The CWCB was created by the state legislature via the Water Conservancy Act of 1937 to "aid in the protection and development of the state's water."[73] A division of the Department of Natural Resources, it is the primary agency responsible for water policy, planning, and project financing in the state. The CWCB was the primary agency responsible for implementing the Statewide Water Supply Initiative (SWSI), a comprehensive assessment of supply and demand

[73] "Water Conservancy Act," Colorado HB 37-265.

planning, and formulated the initial Colorado Water Plan in 2014 under the mandate of 21st Century Act. The agency is scheduled to release a technical supplement later this year.

The CWCB is also the primary state agency responsible for coordinating and liaising with basin-wide roundtables and the IBCC, standing stakeholder committees created under the Water in the 21st Century Act. The roundtable committees' function as a major mechanism for the disbursement of funding for water projects (subject to the concurrent approval of the CWCB.

In conjunction with its work with the basin roundtables, the CWCB oversees the Alternative Agricultural Transfer Methods (ATM) program. The goal of the ATM program is to provide non-permanent rights transfer mechanisms in order to minimize the negative secondary economic and social effects on rural communities ascribed to commonly used buy-and-dry transfers. The Colorado Water Plan mandates that the state implement ATM programs to transfer a total of 50,000 ac-ft. of agricultural water supplies to municipal use by 2030.[74] These methods include seasonal or rotational fallowing water banks; regulated deficit irrigation; crop switching subsidies; improved storage and conveyance infrastructure; "lease-to-fix" transfers with revenues dedicated to development or efficiency improvements; option lease contracts; and buy/lease-back transfer mechanisms. The program began in 2008 and has sponsored 22 pilot programs and 12 study programs over the past decade.[75]

The CWCB is also responsible for the governance of the state's instream flow rights and regulations. Private ownership of instream flow rights is not allowed under Colorado law, designating the CWCB Instream Flows section as the sole owner of instream flows in the state. The CWCB currently holds 1,700 instream flow appropriations throughout the state across 9,700 miles of stream and nearly 500 natural lakes.[76] Acquisition methods for the Instream Flow Program include voluntary rights donation, purchase, or lease as well as via new appropriations. As the ISF program has expanded to include temporary and short-term donations, some stakeholders historically voiced concerns that the program could be used as a mechanism for speculative acquisitions of water rights, particularly in areas likely to affected by a potential CRC call. As a result, the CWCB introduced an official interview process for temporary and short-term ISF transactions to verify the intent of future use. [77]

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[74] Colorado Water Conservation Board, "Colorado's Water Plan," 6-10.
[75] Environmental Defense Fund, "Alternative Water Transfers in Colorado: A Review of Alternative Transfer Mechanisms for Front Range Municipalities," 24-25.
[76] Colorado Water Conservation Board, "Instream Flows."
[77] Interview with CWCB.

6.3 Major Basins and Roundtables

EAST SLOPE

The rivers east of the Continental Divide rise in the Rocky Mountains before flowing east and south to the borders of the state. Consequently, consistent availability of surface flows for appropriation is highly dependent on snowpack accumulation. Unlike the western half of the state, however, the mountain areas generating this snowpack are relatively small and restricted to the upper headwaters of the region. Streamflows in the plains below are only generated by variable (and often limited) rainfall during much of the year. As a result, the total supply of surface water within each watershed is severely limited by flow conditions upstream, and much of the region is fully appropriated. Many of the municipalities of this region have historically relied upon groundwater for their water supply and, constrained by the limits of aquifer availability, are forced to seek alternatives to local surface water in order to supplement their supply in the face of rapidly increasing populations. In the past, these supply gaps have generally been met through surface storage projects and transfers from agricultural use. However, the increasing unpopularity of permanent agricultural transfers in recent years due to the economic consequences to rural communities coupled with the exhaustion of available surface storage capacity has imposed severe limits on the utility of these mechanisms. As a result, much of the discussion and planning for meeting future demands within the region has focused on establishing new alternatives for these communities to obtain sufficient supply for projected increases in demand.

SOUTH PLATTE RIVER BASIN/METRO

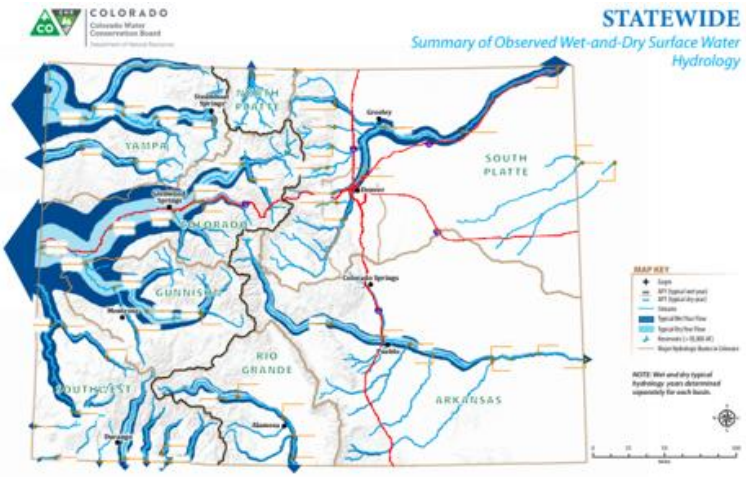
The headwaters of the South Platte River arise in the Mosquito Range of central Colorado in Park County. From there, the river flows northeast through Denver to the confluence with the Big Thompson and Cache la Poudre Rivers before flowing eastward to the Nebraska border at North Platte. The South Platte administrative region also includes the Republican River Basin, a separate tributary of the Missouri basin that drains much of the region immediately west of the Nebraska border. Including the Republican Basin, the South Platte region encompasses an area of 28,000 square miles (roughly comprising the northeastern quarter of the state). The basin contains 22 major reservoirs with a total storage capacity of 1.1 million ac-ft. As of 2016, there were 47,522 existing water appropriations in the South Platte and Republican River basins.[78]

[78] Colorado Information Marketplace, "All Transfers."

Irrigated farmland in the district totals roughly 830,000 acres but is projected to decline by 100,000-176,000 acres by 2050 to provide supplemental municipal water supplies.[79]

The Front Range region of the South Platte basin is notably home to the vast majority of Colorado's population. Municipalities in the region have historically depended on both surface and groundwater supplies to meet their needs. However, many of these municipalities (as well as agricultural and industrial consumers within the region) also depend on large transbasin diversions from west slope basins to supplement their water supply. These diversions are derived from large-scale capture projects (reservoirs and lake diversions) in the headwaters of the mainstem Colorado and Gunnison basins that are subsequently piped across the Continental Divide to Front Range consumers.

Figure 6.2 Major surface flows of Colorado



Source: Statewide Water Supply Initiative

INTERSTATE FLOWS

Interstate apportionment of South Platte surface flows between Colorado and Nebraska are governed by the South Platte River Compact. The compact imposes curtailment on all post-1897 water rights if river flows drop below 120 cubic feet per second during irrigation season.[80]

The physically distinct Republican River in the eastern region of the South Platte district is governed by the Republican River Compact between Colorado, Nebraska, and Kansas. The compact designates a maximum 54,100 ac-ft. of water per year for consumptive use for Colorado subject to defined usage rates for each of the four rivers in the watershed.[81]

[79] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 2.
[80] Colorado Foundation for Water Education, "Citizen's Guide to Colorado's Interstate Compacts," 7-9.
[81] Republican River Water Conservation District, "About the Compact."

The primary area of concern for future water supply planning within the South Platte district is the ability to secure adequate new supplies for growing urban populations without incurring economic and social penalties to rural communities due to decreased agricultural activity. The primary instruments available to meet this supply gap are increased surface storage and expanded transbasin import capacity. ATM pilot programs have also been implemented to provide long-term supplies for domestic use without resorting to buy-and-dry transfers.

SOUTH PLATTE ROUNDTABLE PRIORITIES

The South Platte Roundtable assists with funding and implementation of four agricultural transfer programs, five reservoir improvement projects, and one transbasin diversion improvement project.

Stated priorities of the South Platte Roundtable:

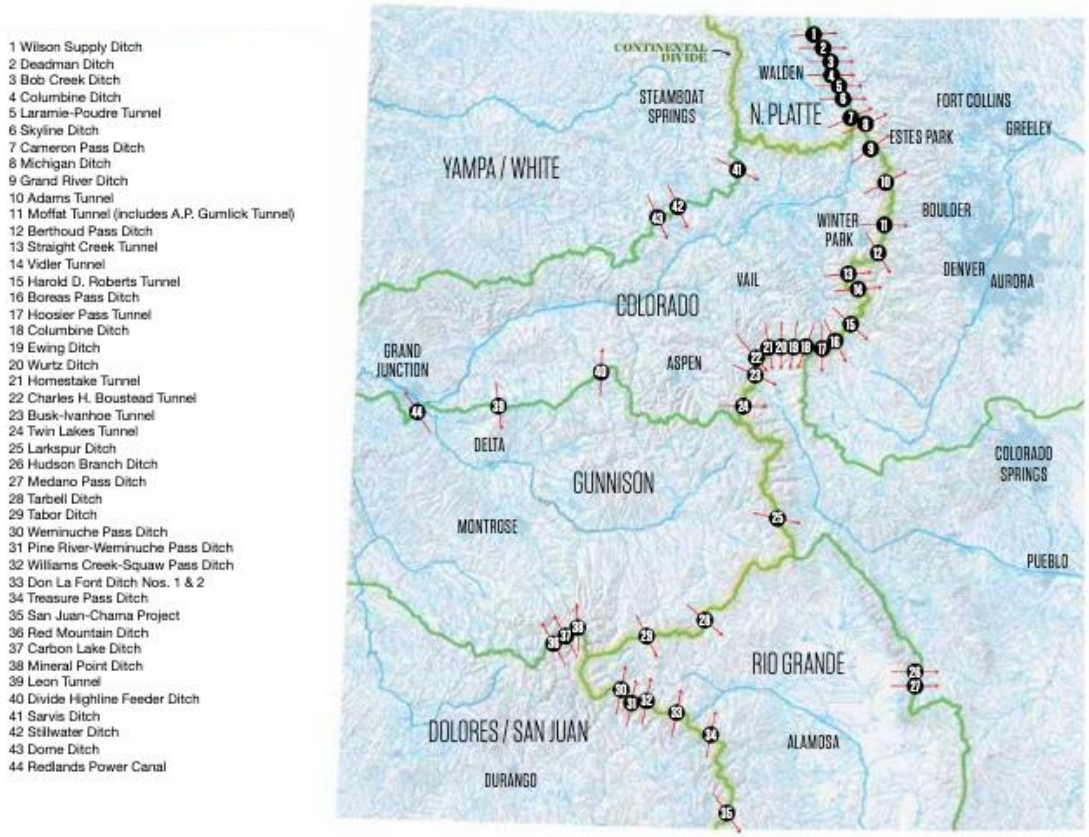
- Address potential impacts of agricultural transfers and finding alternatives to permanent agricultural dry-up
- Address agricultural supply shortages for both surface and groundwater users
- Identify opportunities to optimize existing and future water supply infrastructure
- Successfully implement endangered species program to protect existing and future in-basin uses
- Develop new water storage facilities
- Ensure adequate water for future needs[82]

METRO ROUNDTABLE

Within the South Platte Basin, a separate committee called the Metro Roundtable is designated for the Denver metropolitan area. Unlike the other roundtables, the Metro Roundtable does not oversee water supply management for a watershed. Instead, its primary task is to guarantee secure water supplies for municipal use within the greater Denver metropolitan area. The committee assists funding and implementation of twelve reuse and conservation programs, four agricultural transfer programs, twelve reservoir and storage projects, and four transbasin diversion improvement projects.

[82] Colorado Water Conservation Board, "South Platte Basin Roundtable."

Figure 6.3 Major transbasin diversions of Colorado



Source: Citizen's Guide to Colorado Water Law

Stated priorities of the Metro Roundtable:

- Find alternatives to permanent agricultural dry-up
- Address renewable supplies for Denver Basin groundwater users
- Identify opportunities to optimize existing and future water supply infrastructure
- Ensure successful implementation of endangered species program to protect existing and future in-basin uses
- Ensure adequate water for future needs[83]

[83] Colorado Water Conservation Board, "Metro Roundtable."

ARKANSAS RIVER BASIN

The headwaters of the Arkansas River rise in the Sawatch Mountains of central Colorado near Leadville in Lake County. From there, the river flows south and east across the plains to the Kansas border. The Arkansas basin is the largest in the state, draining an area of 28,000 square miles (roughly comprising the southeastern quarter of the state).[84] The basin contains nineteen major reservoirs with a total storage capacity of 1.8 million ac-ft. Major water imports from the west slope of the Rocky Mountains via eight tunnels and canals account for an average annual volume of 132,000 ac-ft. One major export canal exists to the South Platte basin, averaging 13,000 ac-ft per year. Major municipalities within this region are Colorado Springs and Pueblo. As of 2016, there were 19,452 existing water appropriations in the Arkansas basin."[85] Gross demand in 2030 is projected to increase by 98,000 ac-ft. per year over 2000 demand levels. The basin contains roughly 428,000 acres of irrigated farm acreage, of which an estimated 26,000-63,000 will need to be fallowed in order to provide sufficient municipal water supply.[86]

INTERSTATE FLOWS

Interstate apportionment of Arkansas River surface flows between Colorado and Kansas are governed by the Arkansas River Compact (1949). The compact is administered by the 1980 Operating Principles, which define streamflow apportionment as well as storage accounts and credits in the John Martin Reservoir.[87]

Areas of concern for water supply planning:

- As a result of delivery obligations to Kansas required by the Compact and current appropriations, the Arkansas Basin has very limited water available to new uses and is approaching full appropriation. All new appropriations within the Arkansas basin require augmentation plans. New demand for water rights is predominantly for domestic and municipal use concentrated within the urban counties of the upper basin that have historically relied on declining groundwater sources.
- Alternative water sources for these municipalities have not been forthcoming. Buy-and-dry transfers from agricultural communities are very unpopular due to the economic effects of decreased agricultural activity on rural communities.

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[84] Colorado Water Conservation Board, "Arkansas Basin Fact Sheet."
[85] Colorado Information Marketplace, "All Transfers."
[86] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 2.
[87] Colorado Water Conservation Board, "Colorado's Water Plan," 2-15.

- Many of the surface storage reservoirs in the basin are quite old. Sustaining current storage capacity will require a significant investment in maintenance, restoration, and/or replacement of dams and facilities.[88]

ARKANSAS RIVER ROUNDTABLE

The Arkansas River Roundtable assists with funding and implementation for seventeen projects within the district. Project topics include environmental restoration, infrastructure improvement and expansion, groundwater recharge and storage, mitigation and augmentation planning, and water quality improvement.

Stated priorities of the Arkansas Basin Roundtable:

- Maintain agricultural viability in the lower basin
- Provide for in-basin augmentation in the upper basin
- Provide for adequate water quality to meet all needs
- Ensure adequate water for future needs[89]

RIO GRANDE RIVER BASIN

The Rio Grande Basin is a relatively small watershed draining the San Luis Valley of south-central Colorado. The headwaters of the river arise from abundant snowpack in the San Juan Mountains, but the San Luis Valley itself is one of the driest regions in Colorado. The district contains 622,000 acres of irrigated farmland, which is projected to remain relatively stable over the next several decades due to limited population growth in the region.[90] The vast majority of the district's 17,000 existing water appropriations are dedicated to irrigation.[91] Surface storage projects in the basin are prohibited, severely restricting the region's access to new water supplies.[92]

RIO GRANDE RIVER ROUNDTABLE

The primary water supply concern in the San Luis Valley is the impairment of senior agricultural surface flow appropriations by junior agricultural groundwater appropriations. The roundtable

[88] Colorado Water Conservation Board, "Arkansas Basin Roundtable."
[89] Colorado Water Conservation Board, "Arkansas Basin Roundtable."
[90] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 2.
[91] Colorado Information Marketplace, "All Transfers."
[92] Colorado Water Conservation Board, "Rio Grande Basin Fact Sheet."

supports efforts by the Rio Grande River Conservation District and local conservancy districts to develop effective augmentation plans for groundwater users as well as a nascent local water bank.

Stated priorities of the Rio Grande Basin Roundtable:

- Achieve sustainable aquifers through better management and reduction of groundwater pumping
- Explore augmentation for growth in South Fork and other areas
- Regulate compact deliveries to minimize curtailment
- Ensure adequate water for future needs[93]

WEST SLOPE

The rivers west of the Continental Divide collect as much as 90% of the total streamflows within the state of Colorado, while the western half of the state is home to only 15% of its population. As a result, the Colorado River and its tributaries do not suffer from the same concerns of exhausted appropriation as those on the east slope. Additionally, the west slope headwaters provide a major source of water for use on the east slope via interbasin transfers, primarily for municipal use in the major population centers along the Front Range. In the absence of major municipal and domestic demands, the majority of appropriations in the region service agricultural and stock uses, and demand for new appropriations have increased for the recreation and tourism industries. However, these rivers face major constraints to new appropriations due to the state's obligations to the Colorado River Compact (CRC) of 1922, a major interstate agreement regulating the flow of water for power generation at Lakes Powell and Mead as well as major consumptive uses in other states of the lower Colorado watershed.[94] Record low water levels in Lake Powell this decade have raised fears of a potential call on the entire basin, which would result in extensive curtailments of all post-1922 appropriations, and even senior appropriations are threatened if the pool of junior rights prove to be sufficiently protected by Colorado's domestic preference mandate.

The west slope is also regulated by the Upper Colorado River Compact of 1948, which defines allocations of available basin water to states above Lake Mead (Wyoming, Utah, Colorado, New Mexico, and Arizona). Colorado's apportionment under this compact is 51.75% of basin flows, which permits consumptive use of 3.1-3.9 million ac-ft per year (depending on conditions and

[93] Colorado Water Conservation Board, "Rio Grande Basin Roundtable."
[94] Colorado Water Conservation Board, "Colorado's Water Plan," 2-13.

interpretation).[95] Some rivers (such as the Yampa) are bound to deliver specific minimum volumes, but apportionment between basins is not otherwise defined.

COLORADO RIVER BASIN

The mainstem Colorado River rises in central Colorado and flows west to the Utah border, draining an area of 9,800 square miles.[96] Major municipalities within the basin are Grand Junction and Glenwood Springs. As of 2016, the Colorado district had 19,000 existing water appropriations and about 270,000 acres of irrigated farmland (projected to decline by 40,000-60,000 acres by 2050 to provide municipal water supply).[97]

The abundant streamflows of the Colorado headwaters generate the largest pool of interbasin transfers in the state. The Colorado-Big Thompson project from Grand Lake to the municipalities of the Front Range is the best known, but there are currently sixteen basin export systems to the South Platte and Arkansas Basins in operation and several more proposed.[98] Upper basin communities have become increasingly vocal in their opposition to expansion of export programs, especially in the context of a potential interstate CRC call.[99] The Colorado River Roundtable also currently support a major ATM program sponsored by the Grand Valley Water Users Association.[100] Its goal is to establish a functioning regional water bank within the Grand Valley in anticipation of a potential CRC call in order to ensure access to alternative water supplies in the event of extensive curtailment of post-1922 water rights in the region.

COLORADO RIVER ROUNDTABLE

The Colorado River Roundtable works closely with the Colorado River Water Conservation District to assist supply planning projects. Projects of note include support for the Grand Valley Water Bank pilot program and the West Slope Risk Study.

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[95] Ibid.
[96] Colorado Water Conservation Board, "Colorado Basin Fact Sheet."
[97] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 2.
[98] Water Education Colorado, "Citizen's Guide to Colorado's Transbasin Diversions," 9.
[99] Colorado River Water Conservation District, "Colorado River Risk Study: Phase I Summary Report," 4.
[100] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 27.

Stated priorities of the Colorado Basin Roundtable:

- Address shortages in the headwaters area
- Look at the impacts of transbasin firming projects
- Look at compact delivery impacts to existing and future in-basin water rights
- Ensure endangered species' needs do not negatively impact future in-basin needs
- Identify non-consumptive needs for environmental and recreational flow
- Ensure adequate water supply for future needs[101]

GUNNISON RIVER BASIN

The Gunnison River is a major tributary of the Colorado River in the west central part of the state that drains a basin of 8,000 square miles above its confluence with the Colorado River near Grand Junction.[102] Its headwaters rise in the Sawatch and Elk Ranges, and the basin includes much of southwest central Colorado above the San Juan Mountains. Municipalities in the basin include Montrose and Delta. As of 2016, there were roughly 20,000 existing water appropriations within the basin.[103] The Gunnison district is home to about 270,000 acres of irrigated farmland, projected to decline by 20,000-26,000 acres to provide new municipal water supplies.[104]

The Uncompahgre Valley within the Gunnison Basin is a popular tourist destination, and its historically agricultural communities have seen a marked rise of residential development in recent years. The basin is also home to significant federal reserved rights for environmental flows. Substantial forestation in the region has raised further concerns that water supply reservations should be implemented for firefighting contingencies.

GUNNISON RIVER ROUNDTABLE

Stated priorities of the Gunnison Basin Roundtable:

- Preserve open space
- Maintain agricultural viability
- Provide for in-basin augmentation

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[101] Colorado Water Conservation Board, "Colorado Basin Roundtable."
[102] Colorado Water Conservation Board, "Gunnison Basin Fact Sheet."
[103] Colorado Information Marketplace, "All Transfers."
[104] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 2.

- Address compact delivery impacts to existing and future in-basin water rights
- Ensure endangered species' needs do not negatively impact future in-basin uses
- Ensure adequate water for future needs[105]

YAMPA-WHITE-GREEN RIVER BASINS

The Yampa-White-Green region encompasses several tributary basins to the Colorado River. Together, these river basins drain roughly 10,500 square miles in the northwestern part of the state.[106] This region is predominantly rural, and its major population centers are Steamboat Springs and Craig. Unlike most other west slope watersheds, the Yampa River has flow obligations to the Colorado River defined under the CRC.

The Yampa-White-Green region does not face threats of overappropriation. Much of the land is devoted to stock grazing, and municipal demands are limited by the sparse population. Irrigated farmland in the district comprises merely 120,000 acres and is projected to remain stable over the next several decades.[107] New demand for water rights in the region primarily stems from recreation and tourism as well as increasing protection for habitat and instream flows. The area also contains several locations proposed for future hydroelectric generation sites. As of 2016, the district contained 16,000 existing water rights.[108]

The greatest threat to future supply to Yampa-White-Green is the potential for an interstate CRC call on the Colorado River and its tributaries. Due to the region's relatively late development, the vast majority of water appropriations in these basins are junior to the 1922 compact. As a result, it is likely that many or all of these would be extensively curtailed in the event of a call despite the typically strong flows of the river.

YAMPA-WHITE-GREEN ROUNDTABLE

The uncertain future of existing water appropriations drives much of the activity of the Yampa-White-Green Roundtable. As a result, preservation of senior rights at risk for abandonment is a major priority, as is sponsorship of new surface storage capacity projects. Additionally, the roundtable is a vocal proponent of preserving and expanding non-consumptive rights and uses to

[105] Colorado Water Conservation Board, "Gunnison Basin Roundtable."
[106] Colorado Water Conservation Board, "Yampa/White/Green Basin Fact Sheet."
[107] Colorado Water Conservation Board, "Alternative Agricultural Water Transfer Methods Grant Program Summary and Status Update," 2.
[108] Colorado Information Marketplace, "All Transfers."

support the recreation and tourism industries within the region. Stated priorities of the Yampa-White-Green Basin Roundtable:

- Address potential energy development needs
- Ensure endangered species' needs do not negatively impact future in-basin uses
- Address compact delivery impacts to existing and future in-basin water rights
- Address potential agricultural firming needs
- Ensure adequate water for future needs[109]

SOUTHWEST DISTRICT

The Southwest region includes several tributary basins to the Colorado River, including the Dolores, San Miguel, and San Juan Rivers, encompassing a territory of roughly 10,000 square miles.[110] Major population centers in the region include Durango and Cortez. The region exhibits a high degree of geographical diversity, and as a result its water usage characteristics are highly localized. The Durango area, for example, has seen rapid population growth and transitioning of its economic base from agriculture and mining to tourism and recreation. The Ute Mountain Ute and Southern Ute Indian Reservations, however, remain generally undeveloped.

SOUTHWEST ROUNDTABLE

Stated priorities of the Southwest Roundtable:

- Ensure endangered species' needs do not negatively impact future in-basin uses
- Address compact delivery impacts to existing and future in-basin water rights
- Address potential agricultural firming needs
- Ensure adequate water for future needs[111]

6.4 Water Conservation and Conservancy Districts

Conservation districts are quasi-governmental administrative districts created by the state government to coordinate water supply planning at the basin level. There are currently four conservation districts operating in Colorado (all of which predate the inception of the basin roundtables) and 76 conservancy districts currently in operation in the state.[112] The primary

[109] Colorado Water Conservation Board, "Yampa/White Basin Roundtable."
[110] Colorado Water Conservation Board, "Dolores/San Juan/San Miguel Basin Fact Sheet."
[111] Colorado Water Conservation Board, "Southwest Basin Roundtable."
[112] Colorado Water Conservation Board, "CWCB Data Viewer."

mandate of these districts is to protect the rights of existing water appropriators through legal and technical assistance, policy and planning development, and state-level political representation. The administrative and taxing authority of conservation/conservancy districts is enumerated by the Colorado Water Conservation Act, which empowers districts to levy property taxes within their districts to fund operations.[113] Conservation districts operate at the regional level (described below), while conservancy districts operate projects and programs at the local level.

COLORADO RIVER WATER CONSERVATION DISTRICT

The Colorado River Water Conservation District (CRWCD) was created by the General Assembly in 1937 with the mandate to be "the appropriate agency for the conservation, use and development of the water resources of the Colorado River and its principal tributaries in Colorado."[114] It is composed of 15 member counties in western Colorado located within the Gunnison, Colorado, and Yampa-White-Green watersheds and spanning 29,000 square miles.

The CRWCD operates water banks for the allocation of water from reservoir storage in the Colorado, Yampa, and Eagle River basins.[115] Allocations are contracted on an annual basis for release from reservoir facilities. The CRCWD also contributes to the Grand Valley Water Users Association's ongoing water bank pilot program.

SOUTHWESTERN WATER CONSERVATION DISTRICT

The Southwestern Water Conservation District (SWWCD) was created by the General Assembly in 1941 "to protect, conserve, use and develop the water resources of the Southwestern basin for the welfare of the District, and safeguard for Colorado all waters of the basin to which the state is entitled."[116] Its territory contains the San Miguel and San Juan watersheds, both tributaries of the Colorado River, and includes part or all of nine counties. The SWWCD maintains a diverse project portfolio including streamflow monitoring, water supply augmentation planning, drought contingency planning, and water bank pilot programming.[117] The SWWCD has also facilitated the construction of several large storage reservoirs in its territory.

Due to its location within the Colorado River basin, the SWWCD works closely with the CRWCD to promote compliance and contingency planning pertaining to the Colorado River

[113] Mark Squillace, "Water Transfers for a Changing Climate," 82.
[114] Colorado River Water Conservation District, "Who We Are."
[115] Colorado River Water Conservation District, "Water Marketing."
[116] Southwestern Water Conservation District, "About Us."
[117] Southwestern Water Conservation District, "Programs."

Compact (CRC). Coordinated programming includes the implementation of the Bureau of Reclamation's Pilot System Conservation Program (a study of the utility of water banking for improving Lake Powell water levels), commissioning of the Colorado River Risk Study, and participation in the interstate Upper [Colorado] Basin Drought Contingency Plan.[118] Additionally, both districts have promoted the expansion of the definition of beneficial use to include non-consumptive contributions to CRC compliance obligations.

REPUBLICAN RIVER WATER CONSERVATION DISTRICT

The Republican River Water Conservation District was created in 2004 to manage local water conservation efforts to support the state's compliance with the Republican River Compact. The district's primary goal is the protection of groundwater uses from compact-related curtailments, and its primary instrument for this purpose has been the purchase and retirement of local groundwater rights.[119] The district also sponsors a conservation enhancement program, wherein agricultural land attached to a retired right is converted back to native grassland habitat.[120]

RIO GRANDE WATER CONSERVATION DISTRICT

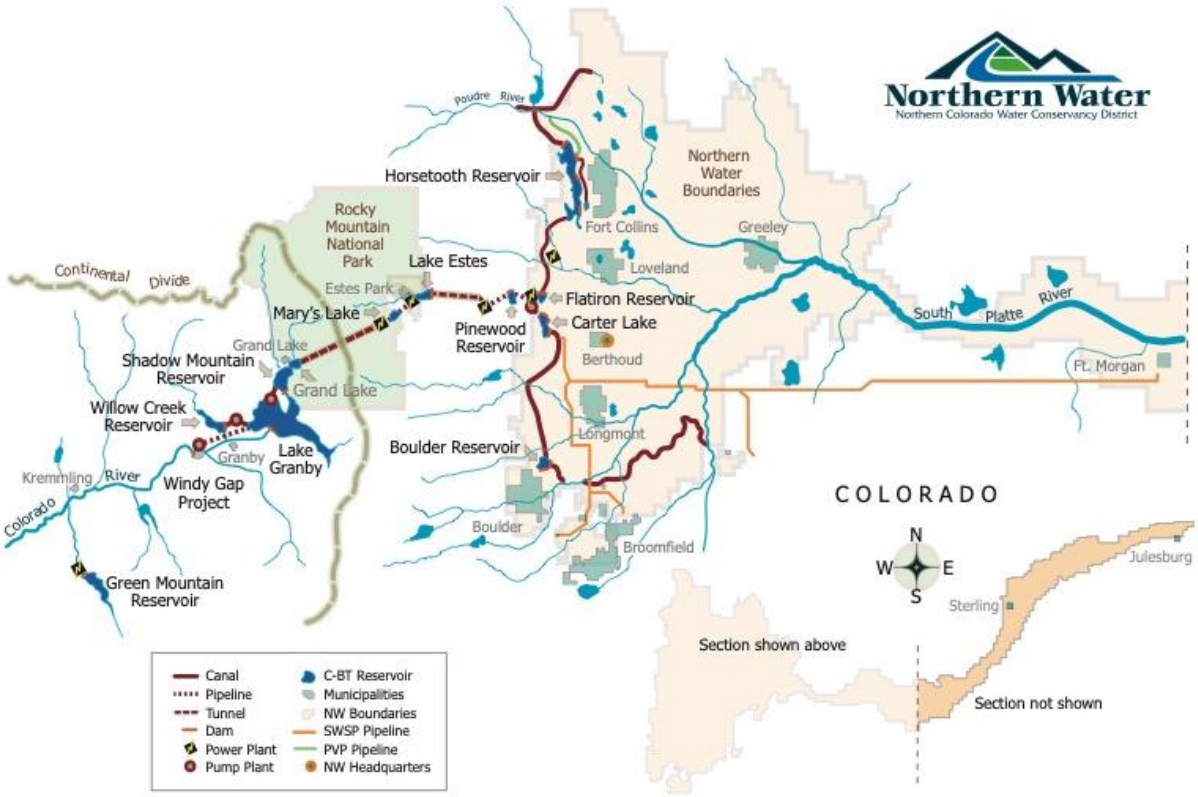
The Rio Grande Water Conservation District was created by the General Assembly in 1967 in southern Colorado. Its mission is "to enhance and protect the water rights of the citizens in the San Luis Valley who reside within the boundaries of the District."[121] The San Luis Valley is the most arid region in Colorado, and its relatively small and economically disadvantaged population is heavily dependent on agricultural production to provide for the welfare of residents. As a result, the district's activities focus on guaranteeing sufficient water supplies for irrigation use. The primary axis of conflict over water rights in the region concerns impairments to senior surface water appropriations by junior groundwater appropriations (where both groups are primarily irrigators).[122] It fulfills this goal by facilitating transfers of senior surface water rights for the fulfillment of augmentation plans for groundwater operations without incurring large-scale land fallowing effects.

NORTHERN COLORADO WATER CONSERVANCY DISTRICT

[118] Southwestern Water Conservation District, "The Colorado River;" Colorado River Water Conservation District, "Colorado River Planning."
[119] Republican River Water Conservation District, "RRWCD Information."
[120] Republican River Water Conservation District, "CREP."
[121] Rio Grande River Water Conservation District, "Home."
[122] Interview with Rio Grande Water Conservation District.

The Northern Colorado Water Conservancy District (Northern Water) was created by the General Assembly in 1937 to operate the Colorado-Big Thompson Project (C-BT) in north central Colorado. Since then, Northern Water has expanded its operations through other transbasin projects designed to provide water supplies for the growing municipalities of the Front Range (including Boulder, Greeley, Longmont and Fort Collins) as well as to agricultural communities elsewhere in the South Platte Basin.[123]

Figure 6.4 Colorado-Big Thompson Diversion System



Source: Northern Colorado Water Conservancy District

As shown in Figure 7.4, the C-BT project collects water from a series of reservoirs and lakes located in the headwaters of the Colorado River. Water is then gravity-fed from Grand Lake through a large tunnel underneath Rocky Mountain National Park. Once on the east slope, water

[123] Northern Colorado Water Conservancy District, "Water Projects."

project water is piped through a series of hydroelectric generation stations as it descends toward district reservoirs for allocation.

The project was constructed by the Bureau of Reclamation between 1938 and 1957 under a partial repayment contract with Northern Water. Project costs were initially estimated at $44 million but increased to $162 million over the course of construction, of which $25 million was repaid by the district. [124] The subsequent Windy Gap expansion was constructed between 1970-85 by Northern Water's Municipal Subdistrict to create new reservoirs for system use west of Lake Granby. [125]

C-BT allocation operates under a shareholder structure. 310,000 individual shares, each representing one acre-foot of maximum annual allocation, were sold at the inception of the diversion project, and each year the district sets a per-share allocation rate (averaging 0.7 acre-feet per year) to be allocated to each share based on available water supplies.[126] Shares may be traded freely throughout the district because Northern Water owns the return flows of its imported water without any place-of-use designation. As a result, shares have been increasingly purchased from agricultural shareholders by municipalities to supplement their water supply portfolios. Critically, the underlying water right remains unaffected by use and transfer of shares.

[124] Northern Colorado Water Conservancy District "The Colorado-Big Thompson Project."
[125] Northern Colorado Water Conservancy District "The Windy Gap."
[126] Mark Squillace, "Water Transfers for a Changing Climate," 83.

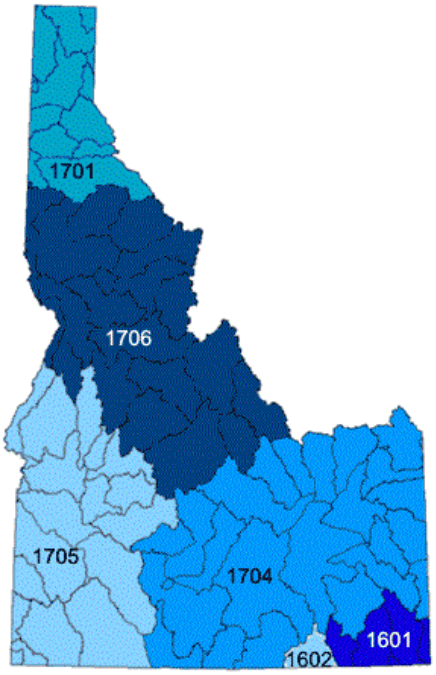
7. IDAHO CASE STUDY

Idaho offers a potential blueprint for creating an economic market for temporary and permanent water rights transfers and rethinking how to manage its water usage outside of litigation. In this case study, we examine Idaho's adjudication, its extensive data collection and modeling, the Idaho Water Supply Bank, the Water Transaction Program, Groundwater Management Areas, and the dual settlement agreements struck between senior surface water and junior groundwater rights holders.

7.1 Physical characteristics

Idaho's watersheds are contained in two USGS hydrologic regions: The Great Basin, for which the Bear River Basin (subregions 1601 & 1602) is hydraulically connected, and the Pacific Northwest. The Pacific Northwest region in Idaho consists of four subregions: The Kootenai–Pend Oreille–Spokane subregion (1701) in northern Idaho, and the Upper (1704), Middle (1705), and Lower (1706) Snake River subregions.

Figure 7.1 USGS hydraulic subregions of Idaho



Source: Digital Atlas of Idaho

SNAKE RIVER BASIN

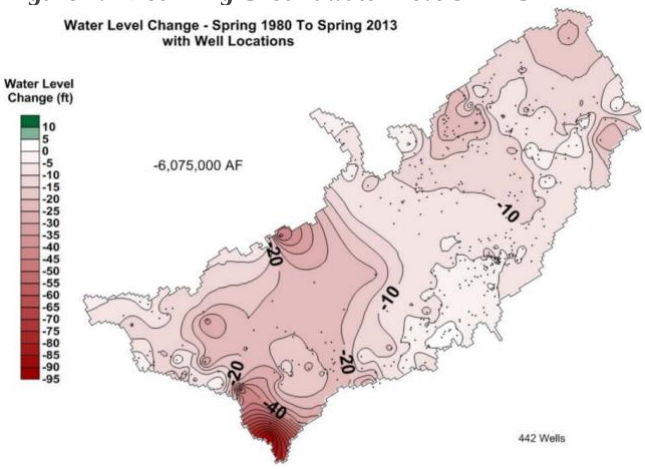
The Snake River is the dominant hydraulic feature of Idaho. It extends from Jackson Lake, Wyoming to its confluence with the Columbia River in Washington. The Snake River Basin is the main drainage basin for most of the state and constitutes approximately 87% of all water rights.[127] Surface water of the Snake River is heavily managed. There are fifteen major dams that manage streamflow, generate hydroelectricity, and enhance navigation and irrigation. Importantly, the river feeds into a series of deep aquifers that provide an abundant supply of water for irrigators and municipalities in an otherwise arid climate.

[127] David Tuthill, Phillip Rassier, and Hal Anderson, "Conjunctive Management in Idaho."

EASTERN SNAKE PLAIN AQUIFER

There are ten aquifers in Southern Idaho that are fed by the Snake River. The Eastern Snake Plain Aquifer (ESPA) is by far the largest. Composed primarily of basalt, the ESPA covers approximately 10,800 square miles and is a key resource for southern Idaho's economy.[128] The region it supplies produces approximately 21% of all goods and services within the state of Idaho, generating an estimated $10bn annually.[129] However, due to increased groundwater pumping to support the region's extensive irrigation, groundwater levels have declined significantly, prompting delivery calls among senior surface water users whose spring-fed streamflow is being impaired. Since 1992, a moratorium has been in place on all new consumptive uses.[130] Idaho Department of Water Resources (IDWR) maintains an extensive ground water level monitoring network of 403 wells in the ESPA and tributary basins to regularly track the volume and water quality in the aquifer. This monitoring network also provides data for the department's groundwater modeling and informs how IDWR issues curtailments.[131]

Figure 7.2 Declining Groundwater Levels in ESPA



Source: IDWR, Statewide Aquifer Conditions Presentation

TREASURE VALLEY

Further downstream from the ESPA is the Treasure Valley. Treasure Valley is home to the state capital, Boise, and has a mix of municipal, industrial, and agricultural water users. The region expects to see rapid population growth, with projections of 1.5 million by the end of the century, nearly double the number of people currently living there.[132] This growth will shift water use away from historically agricultural uses to domestic uses. As part of a sustainability effort,

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[128] Idaho Department of Water Resources, "Eastern Snake Plain Aquifer Comprehensive Aquifer Management Plan."
[129] Ibid.
[130] The moratorium order does not apply to the application for domestic exempt wells, per Idaho Statute 42-111; Idaho Department of Water Resources, "Eastern Snake Plain and Boise River Drainage Moratorium Order | April 30, 1993."
[131] Dennis Owsley, "Statewide Aquifer Conditions."
[132] Narducci, et al., "Projecting Urban Expansion in the Treasure Valley to 2100."

IDWR, under the direction of the Idaho Water Resources Board (IWRB, "Board"), began a partnership in 2016 with USGS to construct a groundwater flow model and improve water management and storage in the area to prepare for the changing water demands.

UPPER SALMON RIVER BASIN

The Salmon River Basin is the largest basin in the Lower Snake River subregion and home to a number of fish listed on the Endangered Species Act (ESA).[133] The Upper Salmon is far less developed than the mainstem of the Snake River, but its aquifer is much smaller and the timing of its discharge is much shorter, resulting in the need for water management strategies. Even so, the area is not a closed basin; IDWR is still issuing permits for new groundwater wells in the Upper Salmon. However, IWRB has instituted policies to work with local farmers and ranchers to implement flow restoration projects that benefit ESA-listed fish.

7.2 Water Administration

IDWR has two prominent organizational missions: water right administration and water resource management. These missions are carried out by the IDWR and the IWRB; the IDWR director oversees the appropriation and compliance of water use via rights administration, while the IWRB is charged with long range planning and carrying out water resource management projects and programs. Section 7.3 will explore Idaho's water resource management strategies.

The IDWR's administrative role is principally to process, record, and ensure compliance in use of authorized appropriation of water via water rights. Idaho's Constitution and state statutes declare all waters of the state to be public waters when "flowing in their natural channels," including the waters of all natural springs and lakes.[134] Groundwater was deemed public water in 1951.[135] In order to divert any water from its natural watercourse or apply water to land, an individual must obtain a water right with IDWR.[136]

WATER APPROPRIATION

Since 1971, appropriation of water rights for both surface and ground water requires the individual to abide by the permit and licensing process, as shown in Figure 7.3.[137] A fee for

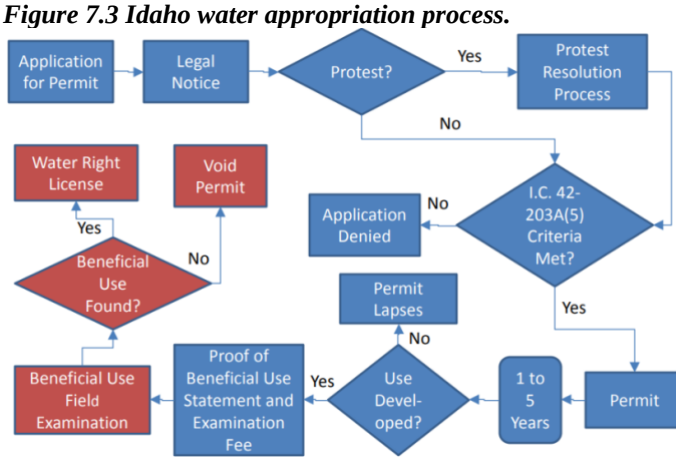
[133] Interview with IDWR.
[134] Idaho Constitution, Article XV, Section 1; Idaho Legislature, Idaho Statute 42-101.
[135] Idaho Legislature, "Ground Waters are Public Waters," Idaho Statute 42-226.
[136] Idaho Legislature, "Illegal Diversion and Application of Water," Idaho Statute 42-201.
[137] Shelley Keen, "Upper Salmon River Basin Water Rights."

application is based on the proposed diversion rate or storage volume requested.[138] After an individual submits their application for permit, IDWR conducts a review to verify the completion of the application and assigns a priority date based upon the submission date of the application. Applications are evaluated based on the following criteria:

- Project must not reduce the quantity of water under existing rights. (i.e., no injury).
- Water supply must be sufficient for the purpose intended.
- Application must be made in good faith, not for delay or speculative purposes.
- Applicant must have sufficient financial resources to complete the project.
- Application must not conflict with the local public interest. (Local public interest is defined as the affairs of the people in the area directly affected by the proposed use).
- Project must be consistent with conservation of water resources within the state of Idaho.
- In a case where the place of use is outside the watershed or local area containing the source of water, the effects on the local economy of the source's watershed or local area must be considered.[139]

The appropriated water right must first pass proof of beneficial use before a water right license is issued. In Idaho, beneficial uses include domestic, irrigation, stock-watering, manufacturing, mining, hydropower, municipal, aquaculture, recreation, and fish and wildlife.[140]

Figure 7.3 Idaho water appropriation process.



Source: IDWR

DOMESTIC EXEMPTION AND DOMESTIC PREFERENCE

Domestic users are not required to apply for a water right permit to use groundwater if their use is less than 13,000 gallons per day. This is commonly referred to as the domestic exemption. Domestic exempt wells can be used "for homes, organization camps, public campgrounds, livestock and for any other purpose in connection therewith, including irrigation of up to one-

[138] The application fee offsets the administrative cost of verifying the completion of each application. For the fee schedule, see Idaho Department of Water Resources, "Instructions for Filing an Application for Permit."
[139] Shelley Keen, "Upper Salmon River Basin Water Rights."
[140] Idaho Department of Water Resources, "A Water Users Information Guide."

half acre of land."[141] The creation of new domestic exempt wells is allowable in closed basins, even where there is a moratorium order in effect. Moreover, because domestic wells are not required to obtain a water right permit, the state cannot curtail their water use following a senior delivery call.[142] This exemption was found unconstitutional in a district court, but the Idaho Supreme Court overruled the district court's decision, holding that the rules that preclude domestic wells from deliver calls were sufficiently in accordance with Idaho Constitution.[143]

Idaho's Constitution does not explicitly exempt all domestic users from curtailment, however.[144] As is the case in most Western states, junior surface or ground water right holders are subject to delivery calls, and those include domestic uses unless they are domestic exempt wells. The Constitution does authorize domestic priority, which allows domestic right holders to use eminent domain to condemn senior irrigation or industrial water rights instituting a delivery call for compensation of those water rights at fair market value.[145] The practical use of this rule, however, is extremely rare.[146]

ADJUDICATION

The adjudication of water rights is a vital component of Idaho's conjunctive administration of water rights. Adjudication has defined the legal limits of individuals' water rights and has helped IDWR manage delivery calls and other administrative process and compliance costs. The state is in the process of fully adjudicating its water including all private, federal, and tribal rights.

The decision to adjudicate the Snake River Basin began with the Swan Falls Agreement. In the late 1970s, a group of ratepayers filed a lawsuit, contending that Idaho Power Company (IPC) had failed to adequately protect its water rights for hydropower generation at the Swan Falls Dam, thereby overcharging its ratepayers. IPC maintained that its water rights were subordinated as a junior hydropower water rights holder to the Hells Canyon Complex.[147] The Idaho Supreme Court ruled in favor of the ratepayers, and following the decision, IPC made a delivery call on approximately 7,500 water rights upstream of the Swan Falls facility, which became known as the "7500 suit." The suit prevented any new development on the Snake River, which created an

[141] Idaho Legislature, "Domestic Purposes Defined," Idaho Statute 42-111.
[142] Idaho Office of the Administrative Rules Coordinator, Department of Water Resources, "Conjunctive Management of Surface and Ground Water Resources," IDAPA 37.03. l 1.020.11.
[143] American Falls Reservoir District #2, et al. v. IDWR.
[144] Interview with IDWR.
[145] Idaho Constitution, Article XV, Section 3.
[146] Interview with IDWR.
[147] Clive Strong and Michael Orr, "Understanding the 1984 Swan Falls Settlement."

intense controversy that expanded into the legislature and resulted in further legal battles that continued for many years.[148]

THE FRAMEWORK OF THE SWAN FALLS SETTLEMENT

Eventually, in 1984, after numerous unsuccessful attempts to legislatively resolve the controversy, the State and IPC entered into negotiations. The State's principals to the negotiations were Governor John Evans and Attorney General Jim Jones. The framework of the settlement set new, lower minimum flows at the Murphy Gage (SSW of Boise) and provided the state with legal authority and tools to protect and enforce minimum flows, and implement state water resource policy to promote "the most efficient and beneficial development of the remaining flows."[149] To adhere to the policy set by the Settlement Agreement, the legislature authorized IDWR to conduct a general adjudication of the Snake River Basin. In an interview with Boise State Public Radio after the completion of adjudication, Deputy Attorney General Clive Strong said, "Prior to the adjudication, we weren't in a position to administer water rights. You can't administer something you can't define. Now we have a comprehensive list of all water rights."[150] Many of the staff we spoke to in IDWR and the IWRB emphasized this point.

THE SNAKE RIVER BASIN ADJUDICATION (SRBA)

In 1987, the commencement order of the adjudication was declared for the entire Snake River Basin. Every landowner was sent a notice to either file their adjudication claim or lose their water right.[151] Participation of domestic exempt wells were optional, but every other surface and ground water rights holder was required to file their claim, including tribal nations and the federal government, authorized by the McCarran Amendment.[152] More than 158,000 water rights in the Snake River Basin were claimed.[153] Most water rights holders negotiated their water rights holdings directly with IDWR rather than through litigation.[154]

The project was estimated to cost $27 million and take ten years to complete; however, in reality the process cost $94 million and took 27 years.[155] The state partially recouped its costs with

[148] Clive Strong and Michael Orr, "Understanding the 1984 Swan Falls Settlement."
[149] Ibid.
[150] Scott Graf, "Why It Took 27 Years and $94 Million To Complete Idaho Water Rights Adjudication."
[151] Interview with IDWR.
[152] David Tuthill, Phillip Rassier, and Hal Anderson, "Conjunctive Management in Idaho."
[153] Ibid.
[154] Interview with IDWR.
[155] Scott Graf, "Why It Took 27 Years and $94 Million To Complete Idaho Water Rights Adjudication."

administrative fees established in rule. The filing fee for domestic or stock water rights holders was $25 and $50 for all other claims with additional variable fees dependent on the type of use and volume used.[156] However, the vast majority was financed by Idaho's state general fund.[157]

One of the unintended consequences of the adjudication was that once a water right was decreed, it reset the forfeiture clock. Forfeiture may occur, in part or in full, if a water is not used for five consecutive years.[158] However, if the right was decreed in the midst of this countdown, the water right holder was given a new five year period.[159] Moreover, IDWR found that some water users who were issued a decree may not have used their water right in over five years, but because it was decreed by the courts, they had an opportunity to put that water back into use. For many of these instances, the water right holder recognized the benefit of leasing their water to the Water Supply Bank in order to obtain forfeiture protection on all or a portion of their decreed water right.[160]

ADJUDICATING THE REST OF THE STATE

Despite the overrun budget and timeline, the Snake River Basin adjudication was largely seen as a success.[161] Adjudicated water simplified delivery calls and stakeholders recognized the importance of understanding where holder's rights begin and end. In 2006, legislators authorized IDWR to proceed with the adjudication of surface and ground water in northern Idaho, with adjudication of the Bear River Basin in southeastern Idaho expected to follow. The decision rested on the projected need for conjunctive administration in these areas, especially due to the interstate nature of some basins. It also was widely believed that the state should take advantage of the water court already in place and the expertise accrued at IDWR.

The decision was not without some controversy. The original charge was intended to make the adjudication a self-funded endeavor, but northern Idaho water rights holders and politicians pushed back and demanded that they were charged the same rate as the SRBA. It also took time to convince water users of its importance, primarily because water is generally more abundant relative to southern Idaho and users did not see the urgency of the need to adjudicate. IDWR contends that southern Idaho was more receptive to adjudication because there is more scarcity,

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[156] Idaho Office of the Administrative Rules Coordinator, Department of Water Resources, "Adjudication Rules," IDAPA 37.03.01.
[157] Scott Graf, "Why It Took 27 Years and $94 Million To Complete Idaho Water Rights Adjudication."
[158] Idaho Legislature, "Exceptions or Defenses to Forfeiture," Idaho Statute 42-223.
[159] Interview with IDWR.
[160] Ibid.
[161] Ibid.

and rights holders appreciated the value of knowing the limits on their and everyone else's water use.

GROUNDWATER MODELING

Adjudicating surface and ground water rights is beneficial to conjunctive administration only insofar as the agency is able to roughly estimate the volume and movement of groundwater to protect against gross over appropriating or catastrophic delivery calls. Largely out of necessity, Idaho has been a leader in groundwater modeling.[162]

EASTERN SNAKE PLAIN AQUIFER MODEL (ESPAM)

IDWR, in collaboration with the University of Idaho, developed its first aquifer model in the 1970s in an effort to better understand the relationship between natural inflows and the mechanical outflows throughout the region. But it was not until the 1990s, following the adoption of conjunctive management rules, that IDWR recognized the necessity of an enhanced model to accurately reflect groundwater. As the state has moved toward a stricter adherence to conjunctive management, the model has had to be updated and improved. IDWR has a network of "sentinel" wells that closely monitor groundwater levels and provide the inputs by which the models are improved.

GEOSPATIAL DATA AND METRIC

Data plays an integral part of managing water resources and refining the state's groundwater models. Knowing the consumptive use of irrigation is a key component of understanding inputs to the aquifer. The state originally relied on county reports on crop type and cover to calculate evapotranspiration (ET). As a result, the data were not very detailed; the unit of analysis was the county. Beginning in the year 2000, IDWR partnered with the University of Idaho and Dr. Rick Allen on a project using satellite imagery to map evapotranspiration at a scale of 30 by 30-meter pixels. The product, which goes by the acronym METRIC—Mapping EvapoTranspiration at high Resolution with Internalized Calibration—became a revolutionary tool in helping create a water budget for groundwater modeling.[163] METRIC data aided IDWR in understanding the water supply of the ESPA even before the department required measurement devices on all groundwater pumps.

[162] Interview with IDWR.
[163] Ibid.

Over time the tool has become a means of managing water withdrawal almost in real time. But the tool is not perfect. Cloud cover can limit the ability to get thermal data, which is an important variable in calculating ET. One in every three or four years, IDWR has to rely on the traditional county-level ground surveys because the weather is too cloudy.[164] And partly for that reason, the tool does not necessarily reduce operating costs for calculating consumptive use.

7.3 Water Resource Management

The IWRB is largely responsible for water management and overall stewardship of the state's water resources. The IWRB directs the formulation and implementation of the state water plan, financing of water projects, and operation of programs. The IWRB is composed of eight board members who are appointed by the governor and serve four-year terms. IDWR supplies staff to manage and support the IWRB's programs and projects. Those programs include: the Water Supply Bank, Water Transaction Program, and aquifer stabilization.

IDAHO STATE WATER SUPPLY BANK

In 1979, the Idaho Legislature authorized the formation of water banking "for the purpose of acquiring water rights… from willing sellers for reallocation by sale or lease to other new existing needs."[165] The Idaho Water Supply Bank is the central mechanism for facilitating the acquisition and voluntary exchange of water rights for new and supplemental water uses. Lessors of water rights can temporarily suspend (bank) their water use authorizations without risking forfeiture. The two arms of the Water Supply Bank are the Board's bank, and regional rental pools.

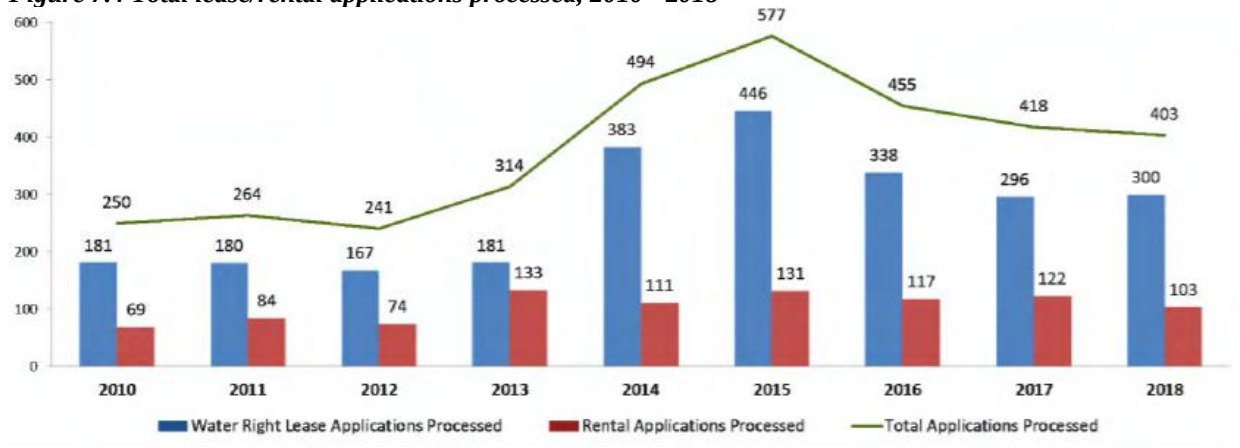
THE BOARD'S WATER SUPPLY BANK

Water rights holders can lease all or part of their water right into the Board's bank. In lease applications, water rights holders are also obligated to disclose present place of use, amount of beneficial use, and any period of non-use.[166] Applications to sell or lease must be submitted with a filing fee. From there, IDWR will process the application to determine completeness for approval.

[164] Interview with IDWR.
[165] Idaho Department of Water Resources, "Water Supply Bank."
[166] Idaho Water Resources Board, "Application to Sell or Lease a Water Right to the Water Supply Bank."

Water rights "parked" in the Board's bank can be rented to new users for a new or supplemental use of water. There is no fee to submit a rental application. The price for rentals is set by the IWRB and the current rental rate is $20 per acre-foot. Once rentals are approved, 10% of the annual rental fee is retained by the state to offset administrative costs; the lessor receives the

Figure 7.4 Total lease/rental applications processed, 2010 - 2018



Source: IWRB

remaining 90%.[167] IWRB also regularly uses the Board's bank to transfer water rights to improve instream flows.[168]

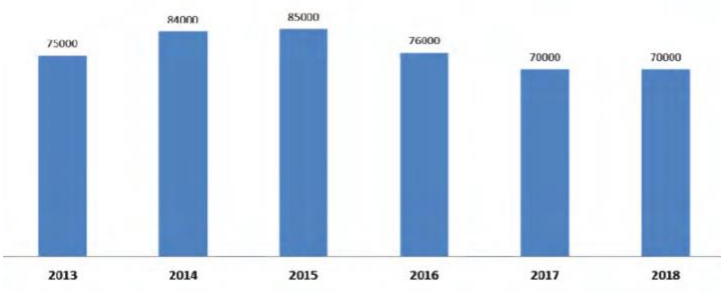
IWRB creates detailed reports each year that document the number of lease and rental applications the Board's bank receives; the term length, volume, and location of those applications; as well as application processing times, fiscal management, and hours logged by IDWR staff to service the program. Figure 7.4 summarizes the number of water right lease proposals and rental requests that were processed from 2010 to 2018. Lease proposals peaked in 2015 at 577 total applications processed and saw a modest decline thereafter. IDWR projects the number of lease and rental applications will slowly grow over the next five years.[169] Approximately 70,000 acre-feet of water is rented from the Board's bank each year (see Figure 7.5). IDWR does not presently track volume potential of leased water rights, because not all water rights leased to the Board's bank feature volume limits (i.e. many senior priority water rights were licensed or decreed without volume limits).[170] A portion of the applications the Board's bank receives are lease proposals intended for specific rental requests, what IWRB calls

[167] Idaho Water Resources Board, "2018 Report for the Board's Water Supply Bank."
[168] Interview with IDWR.
[169] Idaho Water Resources Board, "2018 Report for the Board's Water Supply Bank"
[170] Interview with IDWR.

companion applications. About 23% of water right lease proposals processed during 2018 were companion applications, which continues a trend of gradual decline over recent years.[171]

In 2011, Idaho began charging a filing fee of $250 for lease applications.[172] In the years leading up to the change, IDWR struggled to keep up with demand for water bank services. They found that following the adjudication process, users were keen on obtaining forfeiture protection once the adjudication reset the forfeiture clock.[173] The department decided in order to assign more resources to the program, it needed to generate its own revenue. However, the fee was never intended to make the program self-sustaining. The price was determined through examining other similar filing fees the department charged, such as the permit application.[174] While there is currently no fee to submit a rental request, the department is deliberating whether to propose a rule for one.[175]

Figure 7.5 Annual rental volumes, 2013-2018



Source: IWRB

The Bank's primary expenses are: 1) staff compensation and overhead, 2) coordination and communication changes (advertising and stakeholder engagement costs), and 3) resource research and development changes (technology development and maintenance costs, staff education and consulting fees). Staff compensation makes up the vast majority of the program's expenses. In 2018, IDWR logged over 3,400 hours processing Board's bank lease and rental applications at a cost of roughly $400 per application. Rental applications are significantly more time-consuming to process. These costs are partially offset by revenues from filing fees and approved rentals, but the program operates at a loss each year of about $150,000 on average.

RENTAL POOLS

Rental pools are localized arms of the Water Supply Bank. The pools have a formalized market structure to lease and rent water use authorizations from source-specific reservoirs located on the

[171] Idaho Water Resources Board, "2018 Report for the Board's Water Supply Bank."
[172] Idaho Office of the Administrative Rules Coordinator, Department of Water Resources, "Water Supply Bank Rules," IDAPA 37.02.03.025.02
[173] Interview with IDWR.
[174] Ibid.
[175] Ibid.

Upper Snake, Boise and Payette Rivers, as well as reservoirs within the Lake Fork Creek basin. There are five rental pools in the state, each with its own local committee, appointed by IWRB. By far the largest rental pool is the Upper Snake River Basin. Its advisory committee is called the Committee of Nine. These committee members have a powerful role in Idaho politics, because they manage about 4.1 million acre-feet of storage water that feeds the entire Snake River Basin.

Rental pools consist of common pools and private pools. Through a lease, water supplies are credited to regional rental pools, following which, they can be rented from the rental pool to satisfy new and supplemental water uses.[176] Water supplies credited to common pools are rented at fixed, pre-established rental prices, while water leased to private pools can be rented at negotiated rental rates.[177] Rentals are good for only one year. The price to rent storage water from the Upper Snake River common pool is established by approved rental pool procedures. A certain segment of the rental pool is dedicated to the US Bureau of Reclamation to satisfy flow augmentation needs. Common pool rental prices vary annually and are a function of whether the reservoir system fills. IWRB collects 10% of the gross rental price for storage water rented through the rental pool; however, if no rental price is set for a rental, the IWRB does not levy a fee in those cases.

WATER TRANSACTIONS PROGRAM

The Water Transactions Program was implemented in 2003 by IWRB, to participate in and receive funding from Columbia Basin Water Transactions Program (CBWTP), which is operated by the National Fish and Wildlife Foundation as a contractor for the Bonneville Power Administration (BPA). BPA relies on CBWTP to mitigate for the impacts of the Columbia River dams. Focused on the Upper Salmon River Basin, the program is designed to restore water to streams and rivers and revitalize habitat principally for the benefit of endangered (ESA-listed) species, namely Chinook and sockeye salmon. Idaho Code does not allow for private users to transfer their water rights from an irrigation right to an instream flow right by decree, therefore the IWRB has developed alternatives for improving instream flow.

IWRB can acquire or purchase water rights outright, using money primarily from CBWTP and Pacific Coast Salmon Recovery Fund.[178] As of January 2013, the IWRB held 297 water rights or permits for minimum stream flows, and six water rights for minimum lake levels.[179] However, in

[176] Idaho Water Resources Board, "2017 Rental Pools Report."
[177] Ibid.
[178] Interview with IDWR.
[179] Idaho Department of Water Resources, "Idaho State Water Plan."

the Upper Salmon, permanent transactions of this nature are less of an option—there are currently just 29 instream flow water rights in the Upper Salmon.[180] Therefore to accomplish its objective, the Water Transactions Program relies on three primary tools to meet minimum stream flow: partial- or full-season leases of water rights, minimum flow agreements, and source switch agreements.

TEMPORARY ACQUISITION OF INSTREAM FLOWS

IWRB has the authority to enter into agreements with local water right users to lease the water rights through the Water Supply Bank in order to rent those rights back out to satisfy instream flow purposes. These arrangements can extend for the entire season. In some cases, the state has made recurring agreements that are de facto permanent transfers. Across Idaho there are three of these de facto permanent transfers, and the Water Transactions Program is in the process of securing a fourth.[181]

MINIMUM FLOW AGREEMENTS

IWRB can also set up a contractual agreement with water rights holders to improve streamflow in a river reach that does not run through the Water Supply Bank. Minimum flow agreements require the contracted water user to restrict their delivery on certain days, rather than a full season, to meet target flows. Participants are only compensated for the days they agree to restrict delivery. [182] Depending on the water year and availability, the number of days may vary. Most agreements are capped at 100 days. [183] In most cases, minimum flow agreements are enforced by watermasters.

Figure 7.6 Active transactions in Upper Salmon River Basin

Source: IWRB

[180] Interview with IDWR.
[181] Interview with IDWR.
[182] Idaho Water Resources Board, "Idaho Water Transaction Program."
[183] Interview with IDWR.

SOURCE SWITCH AGREEMENTS

The other main tool the Water Transactions Program uses is a source switch. A source switch is performed by moving the point of diversion of a senior water right from a flow-limited tributary to a tributary that is not flow-limited. The new point of diversion is typically a pump station that will pump water back to the place of use.[184] The result allows the state to increase streamflow between the original point of diversion to the new point of diversion. These agreements are typically long-term and require compensating the water right holder for the increased cost of pumping water from the new diversion point.[185]

GROUNDWATER AND AQUIFER RECHARGE

Idaho is in its fifth year of a large-scale managed aquifer recharge program in the ESPA. The program pays canal companies to carry winter-time recharge water in unlined canals. Water either seeps into the aquifer through the canals or is poured into spill basins.[186] IDWR believes that part of the success of this program has come from its partnerships with canal companies and local irrigation districts.[187]

In some settings where spill basins or unlined canals are not available, IWRB has allowed injection wells to facilitate aquifer recharge. While unable to accommodate the volume IWRB hopes to recharge, injection wells are a viable tool. The state has authorized injection without mandating the injected water to meet clean drinking water standards. IDWR and Idaho DEQ closely monitor water quality through their extensive network of monitoring wells, and reportedly have observed that the aquifer does a satisfactory job of filtering impurities naturally. There have been instances when water quality has been challenged, but it has never reached the Idaho Supreme Court.[188]

Aquifer recharge may not be applicable in every context, however. In the Upper Salmon, the aquifer is shallower and timing of groundwater flow is less understood. A major concern among stakeholders is the potential impact groundwater recharge programs may have on ESA-listed fish migration.[189] Aquifer recharge efforts in the Upper Salmon would likely require diverting peak-season flows because there is no reservoir to manage flows. While an aquifer recharge program

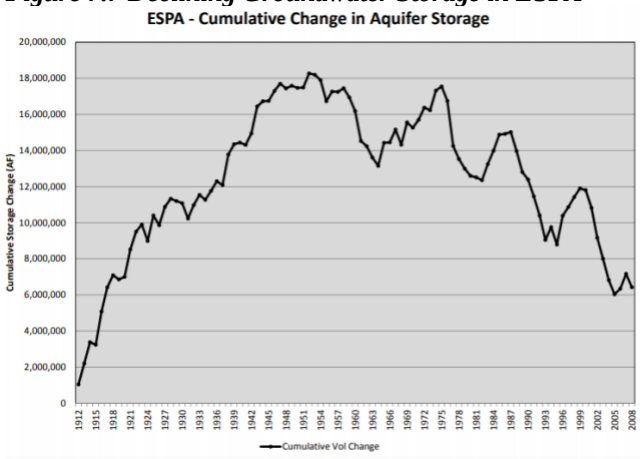
[184] Interview with IDWR.
[185] Idaho Water Resources Board, "Idaho Water Transaction Program."
[186] Interview with IDWR.
[187] Ibid.
[188] Ibid.
[189] Ibid.

might improve off-season instream flows, there are serious concerns that reducing peak flows might have a detrimental effect on in-migration of ESA-listed fish.[190]

GROUNDWATER MANAGEMENT AREAS AND CRITICAL GROUNDWATER AREAS

Critical Groundwater Areas (CGWA) are all or part of a groundwater basin that does not have sufficient groundwater to "provide a reasonably safe supply for irrigation or other uses at the current or projected rates of withdrawal."[191] In a CGWA, IDWR's director can deny an application for a proposed use and may require additional information from groundwater users. The most recent designated CGWA was in 1981.

Figure 7.7 Declining Groundwater Storage in ESPA



Source: IDWR, Statewide Aquifer Conditions Presentation

Groundwater Management Areas (GWMA) are determined by the Director as "approaching the conditions" of a CGWA.[192] In a GWMA, IDWR may deny applications for new water rights if it is determined that there is insufficient supply or injury to senior water rights would result.[193]IDWR usually assembles a local advisory committee to oversee a GWMA. The advisory committee is tasked with evaluating available data and developing a groundwater management plan that is then proposed to the Director for approval.[194] Groundwater management plans can vary in how technical and comprehensive they are, ranging from inventory and measurement to plans to reduce consumptive use. Large sections of the Upper and Middle Snake River Basin are designated GWMAs, including the entirety of the Eastern Snake Plain Aquifer, the Boise metro area and the region surrounding Mountain Home.

[190] Ibid.
[191] Idaho State Legislature, "Critical Ground Water Area Defined," Idaho Statute 42-233A.
[192] Idaho State Legislature, "Ground Water Management Area," Idaho Statute 42-233B.
[193] Ibid.
[194] Interview with IDWR.

SETTLEMENT AGREEMENTS IN THE EASTERN SNAKE PLAIN AQUIFER (ESPA)

The Eastern Snake Plain Aquifer (ESPA) water level has been in decline since the 1950s. IDWR estimates that the aquifer has declined 13.6 million acre-feet, or roughly 215,000 acre-feet per year. This decline has resulted in impacts to surface water flows and natural springs.[195] Due to the conjunctive administration of the state, senior surface water right holders in the Surface Water Coalition (SWC), increasingly relied on delivery calls to protect their water rights from impairment.

Delivery calls were not uncommon, but in 2010, the SWC filed a series of calls that threatened to curtail 157,000 acres of farmland in the Magic Valley, 500 dairy farms, and fourteen cities.[196] A court ruling in 2014 further threatened groundwater pumpers' reliable access to water. The district court judge found that the IDWR methodology for determining injury favored protecting junior groundwater users at the expense of senior surface water users and that curtailment orders should be more frequent and widespread.[197] When the state projected the new injury determinations using historic flows, it found that every fourth or fifth year would see huge and unmanageable delivery calls, curtailing groundwater priority dates back through the 1950s. Such a delivery call would curtail 70-80% of groundwater pumping on the Snake River Plain.[198]

SWC - IGWA SETTLEMENT AGREEMENT

In 2015, Idaho Groundwater Association (IGWA) and SWC entered into negotiations to seek a settlement deal. Idaho's Speaker of the House, Scott Bedke, mediated the settlement agreement at the request of the two groups.[199] Groundwater irrigators agreed to reduce their consumptive use by 240,000 acre-feet annually, or roughly 110% of the observed decline in the ESPA, in order to curb the annual overdraw. At the same time, IWRB launched a managed aquifer recharge program that diverts Snake River water into the ESPA during the winter months (more about aquifer recharge below). IWRB's goal is to recharge 250,000 acre-feet per year, to achieve a cumulative water budget swing of almost 500,000 acre-feet annually.[200] The Agreement's stated goal was to stabilize and reverse the declining ground water levels and return ground water levels in the ESPA to 1991-2001 levels by 2026.

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[195] Ibid.
[196] Idaho Water Resource Board, "Historic Water Settlement Agreement in Southern Idaho."
[197] Interview with IDWR.
[198] Ibid.
[199] Idaho Water Resource Board, "Historic Water Settlement Agreement in Southern Idaho."
[200] Ibid.

The state has exceeded its Settlement Agreement targets for three straight years. IWRB recharged 317,000 acre-feet of water into the ESPA during the winter of 2016-17. Encouraged by its success and a good snow year, IWRB voted to increase its budget for contracting out to recharge partners to $4.7 million for the winter of 2017-18.[201] That season, the state recharged a record 440,000 acre-feet and is expected to exceed 290,000 acre-feet during the 2018-2019 winter.[202]

Other provisions were written into the final agreement: 1) Groundwater users in IGWA would be protected from further water delivery calls or litigation as long as the aquifer recharge benchmarks were met; 2) all groundwater diversions would be required to install flow meters; 3) groundwater irrigators would shorten their irrigation season to April 1 through October 31; and 5) all parties would support IWRB in meeting its goal of recharging an average of 250,000 acre-feet.[203]

Groundwater district leaders left it up to individual irrigators as to how they would reduce their water use.[204] Some junior water pumpers have made use of programs like the Conservation Reserve Enhancement Program (CREP) to get payments for taking marginal farmland out of production.[205] Others have taken advantage of partnering with IWRB to support its aquifer recharge program.

SWC, IGWA, AND SIGNATORY CITIES SETTLEMENT AGREEMENT

As a minority groundwater user, cities were not included in the initial settlement agreement. However, many of the municipal ground water rights were junior to those owned by SWC and IGWA and were liable under the same series of delivery calls that precipitated the SWC-IGWA Settlement Agreement. The cities wanted to implement a long-term resolution to grant them safe harbor from delivery calls, so collectively, the "signatory cities" reached an agreement of their own that became effective January 1, 2019. Rather than reducing use, the agreement allows the signatory cities to continue growing in the future as long as the goals of the first SWC-IGWA Settlement Agreement are met and the signatory cities supply a five-year average of 7,650 acre-

[201] Brian Patton, "Idaho Water Resource Board expects to recharge 524,000 acre-feet into the Eastern Snake Plain Aquifer in winter 2017-18."
[202] Carol Ryan Duma, "Eastern Snake Plain Aquifer recharge shatters record;" John O'Connell, "State exceeds aquifer recharge goal for third consecutive year."
[203] Idaho Department of Water Resource, "SWC-IGWA Settlement Agreement."
[204] Idaho Water Resource Board, "Historic Water Settlement Agreement in Southern Idaho."
[205] Ibid.

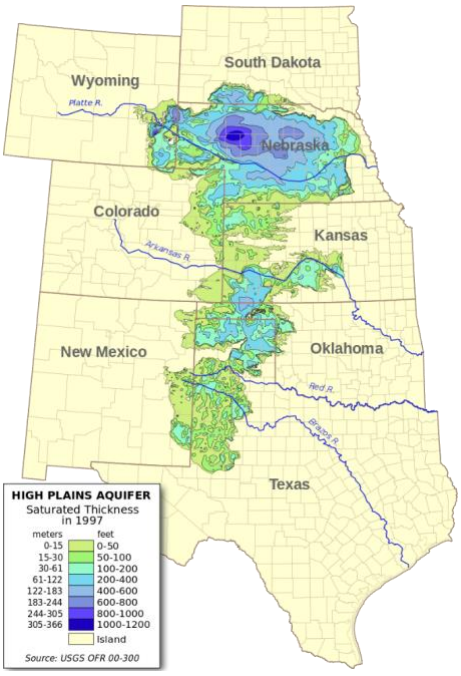
feet per year of water for recharge as mitigation.[206] To accomplish this, cities have purchased storage water from the Snake River reservoirs and either recharge the water themselves or deliver it to IWRB for recharge.[207]

[206] Idaho Department of Water Resources, "Cities Settlement Agreement."
[207] Interview with IDWR.

8. NEBRASKA CASE STUDY

The state of Nebraska provides insight into localized management of groundwater resources and the functioning of markets under different rules and conditions. The implementation of Nebraska's conjunctive management legislation in 2004 increased restrictions on groundwater withdrawals and resulted in legal scarcity, serving as a focusing event for the emergence of groundwater markets. Nebraska's decentralized system of managing groundwater has allowed local agencies to tailor management strategies and rules to hydrogeological and sociopolitical conditions. This case study will examine formal and informal groundwater market structures across five Natural Resources Districts (NRDs) in the Platte River and Republican River basins.

Figure 8.1 Geography and depth of the High Plains (Ogallala) Aquifer



Source: Ogallala Aquifer Program

8.1 Hydrogeology and Climate

Nebraska is located in the Great Plains region of the United States atop the Ogallala Aquifer, a shallow water table (unconfined) aquifer spanning portions of eight states. One of the largest underground freshwater sources in the world, the Ogallala Aquifer supplies 27% of all irrigation water in the United States, including 76% of the irrigation water in Nebraska.[208] Although Nebraska has a large supply of groundwater (65% of the Ogallala Aquifer storage lies beneath the state of Nebraska), increases in irrigated cropland have led to a decline in aquifer levels, especially in the southern area of the state.[209] Annual precipitation in Nebraska ranges from 14-16 inches in the western region of the state to 28-30 inches or more in the eastern part of the state.[210]

[208] Lachman et al., "Water Market Mechanisms;" Karina Schoengold and Nicholas Brozovic, "The future of groundwater markets in the high plains: evolving institutions, aquifers, and regulations."
[209] John Peck, "Groundwater Management in the High Plains Aquifer in the USA: Legal Problems and Innovations;" Mary Kelly, "Nebraska's Evolving Water Law: Overview of Challenges and Opportunities."
[210] Upper Big Blue Natural Resources District, "Groundwater Quantity."

Nebraska has the most irrigated acres of any state, accounting for nearly 15% of total irrigated acres nationwide.[211] The vast majority of total water withdrawals in Nebraska come from groundwater—as of 2010, groundwater withdrawals for irrigation accounted for 80% of total water withdrawals statewide.[212] Increases in groundwater withdrawals led to nearly one million newly irrigated acres between 2002-2007, and a further increase of 800,000 acres between 2007-2016, for a statewide total of 9.3 million irrigated acres in 2016.[213]

8.2 Legal and Statutory Framework

In Nebraska, beneficial use of a water right is defined as any use "by which water may be put to use to the benefit of humans or other species".[214] Beneficial uses in the state of Nebraska include domestic, agricultural/irrigation, manufacturing, power generation, surface and underground storage, groundwater recharge, and instream flows.[215] Nebraska statute recognizes a preference system for water rights for both surface water and groundwater, prioritizing domestic uses above all other uses, and agricultural uses above manufacturing or industrial uses.[216] Although junior domestic or agricultural surface water users (regulated under prior appropriation) may invoke a preference over senior rights, the Nebraska Supreme Court has ruled that these junior users must pay senior users for water used out of priority.[217] However, the domestic groundwater preference statute in Nebraska has only been invoked once, leaving significant legal uncertainty as to how this rule operates in practice.[218]

While surface water in Nebraska is governed by the prior appropriation doctrine, groundwater is governed by a unique combination of the "reasonable use" and the "correlative rights" doctrines. This system gives landowners the right to use the water underlying their property for "reasonable and beneficial use."[219] It also gives groundwater users equal rights during shortages, meaning that competing users must share groundwater resources in times of scarcity. Unlike surface water diversions, which require a permit for any surface water withdrawals, groundwater users must

[211] Johnson et al., "Nebraska Irrigation Fact Sheet."
[212] Mary Kelly, "Nebraska's Evolving Water Law: Overview of Challenges and Opportunities."
[213] University of Nebraska-Lincoln Institute of Agriculture and Natural Resources, "Nebraska Leads the Nation in Irrigated Acres;" Nebraska Department of Natural Resources, "Irrigated Acres in Nebraska, 1964-2016."
[214] Nebraska Legislature, "Terms, defined," Revised Statute 46-706.
[215] Rick Eades, "Instream Flow in Nebraska."
[216] Nebraska Legislature, "Priority of appropriations," Revised Statute 46-204; Nebraska Legislature, "Preference in use," Revised Statute 46-613.
[217] David Aiken, "Priority, Preferences and Irrigator-Power Disputes on the Niobrara River."
[218] Interview with Nebraska College of Law.
[219] Mary Kelly, "Nebraska's Evolving Water Law: Overview of Challenges and Opportunities."

register all wells but are only required to obtain a permit for wells that pump more than 50 gallons per minute.[220]

Nebraska established conjunctive management of surface and groundwater in response to a lawsuit filed by the state of Kansas alleging that Nebraska had failed to meet its surface flow obligation under the Republican River Compact. The Republican River Compact is an interstate agreement between Kansas, Colorado, and Nebraska that allocates 49% of Republican River water to Nebraska, 40% to Kansas, and 11% to Colorado.[221] In 1998, the state of Kansas claimed that excessive groundwater pumping for irrigation on the Nebraska portion of the Republican River had depleted stream flows into Kansas below the amount specified by the compact. The 2003 settlement recognized Kansas' claim, interpreting the language in the compact to incorporate groundwater impacts on surface flows.[222]

In order to ensure compliance with the Republican River Compact under the new settlement in addition to environmental considerations in the Platte River Basin, the Nebraska State Legislature passed LB962 in 2004. LB962 established integrated management of groundwater and surface water statewide in the following ways:

1) Mandating a yearly statewide assessment of basin water availability and providing the Department of Natural Resources (DNR) the authority to designate basins as fully or overappropriated[223]
2) Requiring the DNR and local NRDs to collaboratively author and implement Integrated Management Plans (IMPs) in all basins designated as fully or overappropriated[224]
3) Placing a moratorium on new surface water rights and high-capacity wells[225] in basins designated as fully or overappropriated until the approval of an IMP[226]

The bill prompted an immediate "fully appropriated" designation in parts or all of nine NRDs, concentrated in the southwestern part of the state.[227] Conjunctive management, compliance with

[220] Central Platte Natural Resources District, "Wells."
[221] Mary Kelly, "Nebraska's Evolving Water Law: Overview of Challenges and Opportunities."
[222] Ibid.
[223] Ibid.; Natural Resources Districts in the Republican River Basin imposed moratoria on wells prior to the passage of LB962.
[224] University of Nebraska-Lincoln, "Regulations and Policies, Ground and Surface Water Balance."
[225] Wells that pump more than 50 gallons per minute.
[226] Ibid.
[227] Mary Kelly, "Nebraska's Evolving Water Law: Overview of Challenges and Opportunities."

interstate compacts, and increased groundwater irrigation continue to stress groundwater resources in southwest Nebraska, presenting challenges for local groundwater management.

Although Nebraska has begun considering the surface water impacts of new and prospective gw development and use, statutes do not address conflicts between surface water and ground water users.[228] In 2005, the owners of a local ranch sued upstream groundwater users on the Pumpkin Creek drainage basin in the North Platte NRD for impairing their surface water right. In the *Spear T Ranch v. Knaub* decision, the Nebraska Supreme Court ruled that prior appropriation does not apply to groundwater rights in Nebraska, and that groundwater users are not legally responsible for groundwater withdrawals unless they have "a direct and substantial effect" on surface water.[229] Although this ruling leaves the door open for future cases to determine that groundwater users can impair individual surface water rights, such cases have not yet been brought to the courts. Therefore, legal conflict resolution between hydrologically connected surface and groundwater rights in Nebraska remains unclear.

The Nebraska legislature passed its first instream flow laws in 1984 to recognize instream appropriations for fish, wildlife, and recreation.[230] There are currently instream flow appropriations to protect fish and wildlife on sections of three basins in Nebraska: Long Pine Creek, the central Platte River, and the Niobrara River. However, these instream flow appropriations were created recently enough that they are junior to most other rights.[231] Furthermore, Nebraska's statute relating to instream flow appropriations includes several provisions that substantially reduce the power of instream flow rules relative to some other Western states including Washington.

Like Washington, instream flow rules in Nebraska act as a water right for a portion of a river. However, Nebraska statute states that water rights for instream flows must come from new appropriations.[232] The Nebraska instream flow statute limits the rate of flow that can be protected under an instream flow water right to those flows which have been historically available at least 20% of the time in a river or stream. Additionally, instream flow appropriations are granted only if they are deemed to constitute the best use of water resources alongside other beneficial uses (such as recharge for municipal water systems).[233] Nebraska only allows NRDs and the state Game and Parks Commission to hold instream flow rights, and rules are reviewed and subject to

[228] David Aiken, "Nebraska Supreme Court Decides Pumpkin Creek Case."
[229] Ibid.
[230] Nebraska Legislature, "Appropriation of water for instream flows," Revised Statute 46-2,108
[231] Interview with Nebraska College of Law
[232] Sandi Zellmer, "Instream Flow Legislation."
[233] Ibid.

revision every fifteen years. These provisions make Nebraska's instream flow legislation some of the most restrictive in the Western United States.[234]

8.3 Water Management Structure

Nebraska employs a unique combination of state and local water management. Surface water is managed at the state level by the Department of Natural Resources, and groundwater is managed at the local level by 23 Natural Resources Districts (NRDs). Established in 1972, Nebraska's Natural Resources Districts are multi-county administrative areas defined by river basin boundaries responsible for management of natural resource issues such as erosion, flood control, and drainage in addition to groundwater.[235] NRDs are governed by locally elected boards and are funded primarily by local property taxes and state grants.[236]

Figure 8.2 Natural Resource Districts in Nebraska

Source: Central Platte NRD

In comparison to other states with local groundwater management (such as Texas, where local district authority is vague and often challenged), Nebraska statute grants NRDs broad power.[237] Under the Groundwater Management and Protection Act of 1975, NRDs have the authority to declare a Groundwater Management Areas (GMA) in all or parts of their territories. This allows them to impose restrictions including groundwater pumping limits or allocations (transferable or non-transferable), temporary bans on new high-capacity wells (those that pump 50 gallons or more per minute), well spacing, irrigation rotation, metering of groundwater use, and reduction of irrigated acres.[238] NRDs may impose any of these restrictions on groundwater users in a GMA—therefore, rules regulating groundwater are hyper-local, varying between individual NRDs as well as areas within an NRD.

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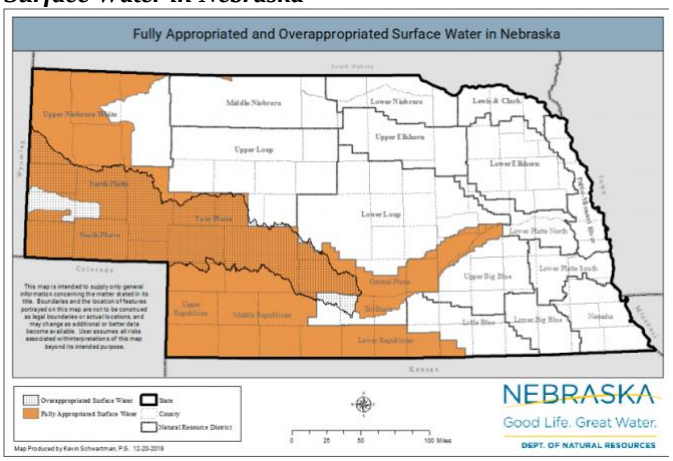
[234] Sandi Zellmer, "Instream Flow Legislation."
[235] West Water Research, "Water Markets in the Ogallala."
[236] North Platte Natural Resources District, "Responsibilities of the NRDs."
[237] Mary Kelly, "Nebraska's Evolving Water Law: Overview of Challenges and Opportunities."
[238] Ibid.

8.4 Water Markets and Transfer Activity

With the exception of the Upper Republican NRD, which has imposed regulations on groundwater withdrawals since 1979, Nebraska's NRDs only began to exercise their authority to place restrictions on groundwater after the passage of LB962, which designated basins as fully or overappropriated.[239] As of 2019, much of the western region of the state has been declared fully or overappropriated, including the entirety of the North Platte, South Platte, Twin Platte, Upper Republican, Middle Republican, Lower Republican, and Central Platte NRDs as well as portions of the Upper Niobrara-White and Tri-Basin NRDs.[240]

Figure 8.3 Fully Appropriated and Overappropriated Surface Water in Nebraska



Source: Nebraska Department of Natural Resources

NRDs in the northern and southeastern parts of the state have largely avoided setting basin-wide restrictions for groundwater use. However, NRDs in the western and southern regions of the state declared fully or overappropriated have imposed restrictions on groundwater users in order to comply with the Republican River Compact, boost stream flows for endangered and threatened wildlife habitat, reduce aquifer depletion, and reduce consumptive irrigation use to a long-term sustainable level specified in each NRD's Integrated Management Plan.[241] As of 2017, eleven NRDs statewide have set an allocation for the maximum volume that groundwater users can pump over a certain period of time. Eleven NRDs have imposed moratoria on new wells throughout the entire district, nine NRDs have imposed moratoria on new wells in sub-areas of the district, and three NRDs have no restrictions on new wells.[242] See Table 8.1 for a summary of regulatory tools used by the five NRDs in this study.

The new conditions of scarcity imposed by these restrictions on groundwater use combined with steady demand for new irrigation water set the stage for the emergence of groundwater trading

[239] Interview with Upper Republican NRD.
[240] Nebraska Department of Natural Resources, "Fully Appropriated and Overappropriated Surface Water in Nebraska," (see *Figure 8.3*).
[241] Chris Thompson and Bruce Johnson, "The Value of Water in Agriculture Land Markets: The Nebraska Case."
[242] Upper Big Blue Natural Resources District, "NRD Groundwater Regulations Across Nebraska."

and an increase in groundwater transfers mostly in the western region of the state. Although informal transfers between farmers likely take place in every NRD in Nebraska, the Central Platte, Twin Platte, South Platte, and Tri-Basin NRDs have seen formal water market mechanisms (implemented by NRDs or private companies) to facilitate transfers between water right holders. In addition, informal trading occurs in the Republican River basin.

Table 8.1 Groundwater Management Tools Across 5 Nebraska NRDs

Natural Resources District	Allocations (maximum volume of water that groundwater users can pump over a specified amount of time)	Flow meters required	Well drilling moratorium	Water use reports required	Cap on irrigated acreage	Land occupation taxes
South Platte	sub-areas: 39”- 48” over 3 years	✓	✓	✓	✓	
Twin Platte			✓		✓	✓
Central Platte			✓	✓	✓	
Tri-Basin	1 sub-area: 27” over 3 years	Only in Republican basin	✓	Only in Republican basin	✓	
Upper Republican	Basinwide: 65” over 5 years	✓	✓	✓	✓	✓

Each NRD created distinct regulatory systems for water right transfers. These systems have indirectly lent themselves to groundwater markets with varying results depending on the design

of the transfer rules and the characteristics of the district. Transfers allow groundwater users to change the location or use of their groundwater right subject to certain rules to avoid causing depletions to streamflow or impairment of existing surface or groundwater users.[243] Rules common among the NRDs we spoke with to minimize the impact to surface water and other right holders include: consideration of stream depletion factor and ratio-based trading, transfer limits by zones or "floating townships," and restrictions on upstream transfers. NRDs must approve every transfer but are not involved in financial transactions.

STREAM DEPLETION FACTOR

NRDs use a Stream Depletion Factor (SDF) to determine the impacts of groundwater pumping on a surface water system over 50 years. The SDF is calculated by dividing the depletion to the river due to well withdrawals over a period of time by the magnitude of well pumping during the same amount of time.[244] This calculation is based on a number of factors including hydraulic conductivity, proximity to river or stream, soil type, saturated thickness of the aquifer, storage coefficient, and more.[245] The difference between the SDF of the place of origin for a groundwater right compared to the SDF of the place of desired transfer corresponds to the amount of the water right that is allowed to be transferred. The use of SDFs results in a ratio-based system of transferring groundwater rights which is designed to ensure that transfers do not result in increased impact to surface water systems.[246]

To calculate SDF, NRDs in the Platte River Basin use the Cooperative Hydrological Study (COHYST) 2010 modeling software, which was developed out of the overall COHYST study of the Platte River Basin. The COHYST model is comprised of three existing models to capture effects of withdrawals to both surface and groundwater: the watershed model based on CROPSIM and FORTRAN software; a surface water model based on STELLA software; and a groundwater model based on MODFLOW 2005 software.[247]

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[243] Nebraska statute stipulates that Integrated Management Plans include methods to "estimate depletions and gains to streamflow including location, amount, and time" for areas of hydrologically connected surface and groundwater, and states that new uses should not have more than a "de minimis" impact on existing surface and groundwater users. Nebraska Legislature, "River basin, subbasin, or reach," Revised Statute 46-715.
[244] Twin Platte Natural Resources District, "Districtwide Ground Water Management Area and Integrated Management Sub-Area Rules and Regulations," 10.
[245] Ibid.
[246] Yusuke Kuwayama and Nicholas Brozovic, "The Regulation of a Spatially Heterogeneous Externality: Tradable Groundwater Permits to Protect Instream Flows, *Journal of Environmental Economics and Management*, 2013.
[247] Cooperative Hydrological Study, "2017 Documentation Report for COHYST 2010 Model."

UPPER PLATTE RIVER BASIN

The Platte River Basin is comprised of the North Platte and South Platte rivers. The North Platte River originates in Wyoming, while the South Platte River has its headwaters in Colorado. Both rivers flow westward into Nebraska, where they converge, eventually emptying into the Missouri River in eastern Nebraska. The Platte River Basin is critical habitat for several federally listed endangered species including the whooping crane, pallid sturgeon, and least tern. In 1997, Colorado, Wyoming, Nebraska, and the Department of Interior signed a cooperative agreement to increase stream flows in the Platte River to reduce impacts to critical habitat. From 1997-2005, representatives from the federal government and the three states, environmental organizations and water users collaboratively developed the Platte River Recovery Implementation Program (PRRIP). PRRIP requires the state of Nebraska to offset all new depletions of the Platte River Basin after 1997, aiming to increase streamflow in the central Platte portion of the basin by 130,000-150,000 acre-feet in the first increment of the program (2007-2019).[248]

Five NRDs in Nebraska are situated along the Platte River Basin: the North Platte NRD, South Platte NRD, the Twin Platte NRD (where the North and South Platte Rivers converge), and the Central Platte NRD. The Tri-Basin NRD encompasses parts of the Platte River Basin, the Republican River Basin, and the Blue River Basin. As a result of the Platte River Cooperative Agreement, all five of these NRDs must mitigate for new groundwater depletions and restore streamflows to 1997 levels in the Platte River Basin. These requirements, in conjunction with the overappropriated status of the Platte River above the Kearney Canal in the Central Platte NRD, required NRDs to imposed restrictions on new uses of groundwater along the basin.

In addition to authorizing transfers, all NRDs in the Upper Platte River Basin operate water banks, which are distinct from the transfers between individual users that take place on a day to day basis. The specific definitions of these entities vary by NRD. Both the Twin Platte and the South Platte NRDs define a "water bank" as "a procedure for tracking additions and/or reductions in ground water consumptive use within the district", while the Central Platte NRD states that its water bank is "for the purposes of encouraging and facilitating the transfer of water between users".[249] In practice, all four NRDs use these banks to offset new or expanding consumptive uses and to augment flows in the Platte River in the effort to return to 1997

[248] Central Nebraska Public Power and Irrigation District, "Platte River Recovery and Implementation Program."
[249] Twin Platte Natural Resources District, "Districtwide Ground Water Management Area and Integrated Management Sub-Area Rules and Regulations." 11; South Platte Natural Resources District, "Integrated Management Plan," 13; Central Platte Natural Resources District, "Integrated Management Plan," 8.

streamflow levels in compliance with rules; some NRDs allow transfers of deposits into the water banks while others do not. NRD rules also commonly stipulate that the NRD is the only entity with the authority to run a water bank within their district. In most NRDs right holders can deposit water into the district's water bank and remove it later for future use, or else transfer it to another use subject to NRD transfer rules.

SOUTH PLATTE NRD

The South Platte NRD is located on the southernmost part of the Nebraska panhandle atop two principal aquifers, the Ogallala and the Brule Formation (considered to be a major aquifer where fractured). 96% of water use in the district is used for agricultural irrigation (130,000 irrigated acres) compared to 3% municipal use and 1% industrial use.[250] Primary crops grown include alfalfa, corn, beets, beans, and wheat.[251] Lodgepole Creek, which originates in Wyoming, runs west to east through the district before emptying into the South Platte River in Colorado just across the southern border of the NRD. The South Platte NRD receives an annual rainfall of about 16 to 18 inches, making it one of the drier districts in the state.

The hydrogeology of the Brule and Ogallala aquifers has led to variable water supply throughout the district—groundwater declines in certain areas of the district led to the establishment of management sub-areas along geological boundaries that are subject to increased restrictions.[252] In the early 2000s, the South Platte imposed a moratorium on new wells in an area of the basin, and in 2004 the DNR designated the entire South Platte NRD as fully appropriated or overappropriated.[253] As a result, the South Platte has no basin-wide allocation, but imposed three different allocations that dictate how much water well owners can pump over a three year period—the amount of the allocation varies by sub-basin according to hydrological characteristics and aquifer recharge rates.[254] All large capacity groundwater wells in the district are required to have flow meters.

The South Platte NRD allows both temporary and permanent transfers of allocations (in acre-feet of water and certified irrigated acres) as well as pooling agreements. Although Mammoth Trading operates a smart market in the district, staff at the South Platte NRD estimate that the district receives only one or two transfers per year as a result of their stringent transfer rules. For

[250] Interview with South Platte NRD.
[251] South Platte Natural Resources District, "Integrated Management Plan."
[252] Interview with South Platte NRD.
[253] Ibid.
[254] Ibid.

example, acres that have both surface and groundwater rights can only be transferred to other parcels of land that have both surface and groundwater rights unless the landowner cancels their surface water right. Additionally, transfers of irrigated acres are allowed only after a flow meter has been installed for at least three years (equivalent to one allocation cycle) in order to establish an irrigation history.[255] NRD staff identify their policy of only allowing transfers within "floating townships" (contiguous blocks of 6 by 6 mile areas throughout the district), which they implemented to prevent impairment to surface water, as their most restrictive rule.[256] The South Platte and the Upper Republican are the only NRDs that use this rule.

South Platte NRD agency staff expressed the importance of maintaining local control over certain regulations—for example, staff explained that the moratorium on large capacity wells and allocation requirements were intentionally omitted from the Integrated Management Plan developed in conjunction with the DNR as a way to preserve autonomy from the state on certain command-and-control regulations.[257] In contrast, the North Platte NRD's allocation is included in their joint Integrated Management Plan (as a result of higher environmental impacts to streamflow in their district), leaving these regulations open to state control.[258]

According to NRD staff, the South Platte's water bank accepts deposits, decertifies them, and converts them into conservation easements to boost streamflows.[259] However, unlike other NRDs we spoke to, the South Platte does not allow the transfer of acres deposited into the water bank to new uses.

CENTRAL PLATTE NRD

The Central Platte NRD is located east of the Twin Platte NRD in central Nebraska. The Central Platte NRD is the most populous of the western Nebraska NRDs with a municipal population of about 138,000. The district encompasses 11 counties and 2.1 million acres, about half of which are irrigated and used primarily to grow corn and soybeans.[260] Groundwater is the major source of irrigation water—of the approximately one million irrigated acres, only about 40,000 are

[255] South Platte Natural Resources District, "Districtwide Groundwater Management Area Rules and Regulations," 25-26.
[256] Interview with South Platte NRD.
[257] Ibid.
[258] Ibid.
[259] Ibid.
[260] Interview with Central Platte NRD.

irrigated with surface water.[261] The Platte River is the primary waterway in the NRD, spanning the entire length of the district.

The portion of the Platte River that runs through the Central Platte NRD is the most critical area for endangered species throughout the entire basin, prompting efforts to obtain water rights to augment streamflows by the district and other programs. In particular, the Platte River Recovery Implementation Program (PRRIP) leases surface water rights for instream flows from the Central Platte NRD as well as from individual irrigators in the Central Nebraska Public Power and Irrigation District.[262] In addition, both the Central Platte NRD and the Nebraska Game and Parks Commission hold instream flow appropriations on the Platte River for endangered species habitat.[263]

After the passage of LB962, a small portion of the western region of the Central Platte NRD was designated as overappropriated, and the rest of the district was declared fully appropriated.[264] Like the Twin Platte, the Central Platte NRD opted to respond to prohibit expansion of irrigated acres without an offset and certify irrigated acreage rather than impose allocations and metering requirements; the NRD enforces acreage with annual flyovers using infrared photography.[265]

The Central Platte NRD worked with USGS to define 24 sub-areas for water quantity management based on hydrogeological features. All of these areas have specified amounts of "acceptable decline" for groundwater. To date, the Central Platte NRD has never hit these specified amounts for any of their sub-management areas--if they did, they would be mandated to impose further restrictions.[266]

The Central Platte NRD uses the COHYST 2010 modeling software to evaluate every transfer in the district. This software incorporates differences in Stream Depletion Factor (SDF) between location of origin and location of transfer when evaluating transfers, however, the Central Platte NRD administers their SDF transfer rules in a unique way. When a right is transferred from an area of low depletion to an area of high depletion, the number of irrigated acres transferred are reduced accordingly to ensure an equal impact on streamflow. When a right is transferred from an area of high depletion to an area of low depletion, the computer software allows the number of irrigated acres transferred to increase relative to the original use provided that there is no

[261] Interview with Central Platte NRD.
[262] Interview with Platte River Recovery and Implementation Plan.
[263] Ibid.
[264] Interview with Central Platte NRD.
[265] Ibid.
[266] Ibid

increase in depletion to streamflow.[267] This is the only NRD that has this rule—other NRDs stipulate that transfers from areas of high depletion to low depletion are at a ratio of 1:1 to avoid increasing the total number of irrigated acres in their districts.[268]

NRD rules also only allow groundwater transfers to move one mile upstream (west).[269] Like the Twin Platte NRD, the Central Platte NRD only allows permanent transfers of certified irrigated acres.[270] The Central Platte sees some of the highest transfer activity in the state—Central Platte staff estimate they process about 200 permanent groundwater transfers every year.[271]

In 2016, the Central Platte NRD launched a Groundwater Exchange Program with the goal of allowing producers increased flexibility to lease water on a short-term basis while also allowing the NRD, PRRIP, and environmental groups to lease water for instream flow purposes. The program allowed participants to lease water for irrigation or instream flows for one growing season and was structured as an online auction where buyers and sellers would submit offers via a sealed bidding process. Smart market software then matched buyers and sellers, taking the district's rules and regulations into account. The online exchange platform and smart market software were developed by a consultant, who the Central Platte NRD paid $40,000-$50,000 per year to run the program.[272]

Participation rates in the program weren't as high as the Central Platte NRD was anticipating they would be—in the second year of the exchange, about twelve sellers received bids that matched with five buyers.[273] On average, these trades were about 35 acre-feet each.[274] An additional goal in establishing the bank was to try to determine the value of water in the district, and prices to lease water for one growing season were far cheaper than the district had anticipated.[275] For example, bids for transfers within the district during the second year of operation ranged from $8.14-$121.07 per acre, in contrast with permanent transfers which usually range from $2,000-$3,500 per acre.[276] This aspect of the NRD's transfer rules made it cheaper per irrigated acre to transfer to other agricultural uses farther away from the river than to environmental uses. The program also led to an overall increase in irrigated acres in the district

[267] John Thorburn, "Overview and Summary of NRD Certified Irrigated Acre Transfer Policies."
[268] Ibid.
[269] Central Platte Natural Resources District, "Groundwater Quantity Management Plan."
[270] Interview with Central Platte NRD.
[271] Ibid.
[272] Ibid.
[273] Ibid.; Central Platte Natural Resources District, "Groundwater Exchange Program."
[274] Interview with Lyndon Vogt.
[275] Interview with Central Platte NRD.
[276] Central Platte Natural Resources District, "Groundwater Exchange Program."

due to the Central Platte's rule that makes it possible for groundwater rights holders to expand their irrigated acreage.[277]

Due to low participation and the high cost of running the program compared to the benefit for producers, the Central Platte discontinued the program in 2018 after three years of operation.[278]

TWIN PLATTE NRD

The Twin Platte NRD is located between the South Platte and Central Platte NRDs in western Nebraska. The Twin Platte NRD encompasses all or parts of four counties and holds 2.6 million acres including 321,000 irrigated acres owned by an estimated 1,000 farmers.[279] The North and South Platte rivers converge in the Twin Platte NRD to form the mainstem Platte River, representing three distinct river systems. The geological and hydrological conditions vary within the district, ranging from the dry Nebraska Sandhills in the north to the North and South Platte River valleys which are mainly comprised of irrigated farmland used to grow corn and soybeans. As in other NRDs in western Nebraska, the largest use of water is agricultural, with limited municipal and industrial uses—the largest population center in the district is the town of North Platte with a population of about 25,000 people.[280]

After the passage of LB962 in 2004, DNR designated the entire Twin Platte NRD as fully appropriated (in addition to the overappropriated designation of the Platte River Basin).[281] The Twin Platte sought to avoid allocations and metering and designed a system that would provide more flexibility to landowners in the district to be able to expand development while still controlling for consumptive use and mitigation for new uses.[282] Therefore, unlike other NRDs in western Nebraska that have imposed allocation restrictions on the amount of groundwater users could pump over a certain number of years, the Twin Platte has instead capped irrigated acreage expansion. The Twin Platte also certified all existing acres in the district and allowed for trading of certified irrigated acres (CIAs) subject to a set of internal transfer rules. All transfers of CIAs must occur within the same basin, and all transfers are subject to an adjustment of the right based on the difference in Stream Depletion Factor between the place of origin and the place of transfer. Additionally, the NRD has outlined transfer limitation zones, which place restrictions

[277] Interview with Mammoth Trading; Interview with Water for Food Institute.
[278] Interview with Central Platte NRD.
[279] Interview with Twin Platte NRD.
[280] Ibid.
[281] Twin Platte Natural Resources District, "Districtwide Ground Water Management Area Rules and Regulations."
[282] Interview with Twin Platte NRD.

on transfers based on diversion points along a basin—while groundwater users can transfer CIAs across zones, upstream transfers are only permitted within a transfer limitation zone.[283]

There are no restrictions on the amount that groundwater users can pump in the Twin Platte, which eliminates the need for metering, which has been politically unpopular and can lead to increased financial and staff time costs to NRDs (instead, the Twin Platte conducts aerial flyovers to enforce rules).[284] Additionally, there is little incentive for well owners to over-pump since water can only be used on a certain number of irrigated acres that are largely homogenous in terms of consumptive water use; excess pumping would lead to increased energy costs incurred by the grower for no benefit.[285] Since water trading is attached to land, the Twin Platte only approves permanent transfers rather than temporary leases, as the cost to buy equipment and begin producing on a farm is too high for growers to engage in for the short-term.

Mammoth Trading, Inc. operates a smart water market in the Twin Platte, using technology that applies the NRD's transfer rules to match buyers and sellers. Apart from that, information about available acres and interested parties typically travels through word of mouth, with prices largely dictated by the price of corn.[286] Agency officials from the Twin Platte note that landowner education on the importance of rules and regulations poses significant challenges, especially given the large number of out-of-state second homeowners in the district. However, they also report that their district's very clear rules and transparency aids in education and helps build trust with landowners.[287]

Irrigators who do not currently use all of their groundwater right have the option to deposit the unused portion into the NRD's water bank, which allows the user unlimited time to withdraw at a future date and transfer to another location, or sell to another user.[288] While the acres are located in the bank, the NRD gets "credit" as increased inflow to the Platte River for those acres in the short-term.[289]

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[283] Twin Platte NRD, "Annual Report of Water Use Activities in the Twin Platte NRD."
[284] Richael Young, "Smart Markets for Groundwater Trading in Western Nebraska: the Twin Platte."
[285] Ibid.
[286] Interview with Twin Platte NRD.
[287] Ibid.
[288] Twin Platte NRD, "Annual Report of Water Use Activities in the Twin Platte NRD."
[289] Ibid.

TRI-BASIN NRD

The Tri-Basin NRD is located in south central Nebraska, and encompasses parts of the Republican, Platte, and Little Blue Basins. More than half of the land in the district is devoted to irrigated cropland.[290] Following passage of LB962, when portions of the Tri-Basin were designated as fully and overappropriated, the NRD placed a moratorium on additional development of irrigated lands and implemented allocations to limit groundwater pumping in one township due to observed groundwater level declines. The Tri-Basin only allows permanent transfers, and NRD staff estimate processing about 10-20 permanent transfers per year.[291]

The Tri-Basin NRD must comply with inter-state agreements in the Platte and Republican Basins, leading to different rules within different areas of the NRD. For example, although the Tri-Basin has no district-wide metering requirement, groundwater users in the Republican Basin must install flowmeters and report water use. NRD leadership has been split on whether to mandate metering throughout the district—while some are in favor, others are hesitant to impose regulations.[292]

In an effort to incentivize groundwater metering and reporting without directly mandating it, the Tri-Basin NRD created the Water Conservation Incentive Program.[293] To participate in the program, farmers enroll certified irrigated acres in exchange for a payment from the NRD.[294] Landowners must sign a five year contract committing to allocations on their water use for the acres they enroll (these allocations vary by the average corn crop irrigation requirement in the three counties in the district). In addition, farmers must agree to install groundwater well meters (with a cost-sharing option provided by the NRD) and to report their annual water use. Farmers can choose between an annual payment of $5 per acre-inch credit per year, or a $4 payment per acre-inches of credits for up to five acre-inches per acre at the end of five years.[295]

Each parcel enrolled in the program has its own account where the NRD will keep track of the number of acre-inches of water available for use. Farmers can sell additional credits from unused allocations to other landowners at a negotiated price or to the NRD for a set price.[296] Sellers can also post available acres for sale on an online bulletin board operated by the NRD, however, the

[290] Interview with Tri-Basin NRD.
[291] Ibid.
[292] Ibid.
[293] Ibid.
[294] Tri-Basin Natural Resources District, "Tri-Basin NRD Water Conservation Program."
[295] Ibid.
[296] Ibid.

NRD has the right of first refusal to purchase any unused allocations from landowners.[297] Producers are allowed to pool their allocations between multiple parcels in the same basin. If a landowner overuses their allocation, they must purchase water credits from other landowners to make up the deficit, or they will be banned from irrigating on those acres until the deficit is eliminated.[298]

At the end of the first two-week enrollment period in April 2019, the NRD had enrolled about 4,000 acres, half of the 8,000 acre cap.[299] Since the program is still in its nascent stage, successful participation rates remain to be demonstrated; however, NRD leadership is hopeful that it will increase irrigation efficiency and decrease overall groundwater pumping.[300]

UPPER REPUBLICAN NRD

The Upper Republican NRD lies in the southwestern corner of the state. The district encompasses three counties and about 1.7 million acres of land, more than half of which is used as cropland to grow primarily corn, soybeans, and wheat.[301] The Upper Republican is a rural district with a total population of about 9,000 and limited municipal water use.[302] Groundwater depletions in the district are some of the largest in the state—from predevelopment to spring 2017, areas of the Upper Republican NRD have experienced up to 60-80 foot declines.[303]

In addition to groundwater depletions, compliance with the Republican River Compact is the major impetus for groundwater regulation in the Upper Republican NRD.[304] The Upper Republican NRD is designated as fully appropriated, and has imposed regulations on groundwater use including a cap on irrigated acres, a districtwide allocation of 65 inches of water per acre over three years with an option to bank and carryforward unused allocation, a moratorium on new wells, required flow meters and water use reports, and a $10 per acre occupation tax on all irrigators in the district to fund projects to enhance streamflow.[305]

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[297] Tri-Basin Natural Resources District, "Tri-Basin NRD Water Conservation Program."
[298] Ibid.
[299] Interview with Tri-Basin NRD.
[300] Tri-Basin NRD, "Tri-Basin NRD Groundwater Conservation Incentive Program."
[301] Nicholas Brozovic, "Upper Republican Natural Resources District," 72-80.
[302] Ibid.
[303] University of Nebraska-Lincoln, Institute of Agriculture and Natural Resources, "Nebraska Statewide Groundwater-Level Monitoring Report."
[304] Interview with Upper Republican NRD.
[305] Upper Republican Natural Resources District, "Groundwater Management Rules and Regulations;" Nicholas Brozovic, "Upper Republican Natural Resources District."

The Upper Republican NRD allows trading of certified irrigated acres as well as allocation. District rules stipulate that unless certain conditions are met, all transfers must take place within a floating township (a six-mile tract of land) and must take Stream Depletion Factor into account.[306] The district also allows landowners to combine their allocations in "pooling agreements" within a floating township.[307]

The Upper Republican NRD currently processes about ten transfers between irrigators per year. These transactions occur at a price of about $2,500 per acre negotiated on the private market.[308] Unlike NRDs in the Platte River Basin, the Upper Republican NRD does not operate a water bank to mitigate for new uses, although agency staff said they could imagine doing so in the future.[309]

[306] Interview with Upper Republican NRD.
[307] Nicholas Brozovic, "Upper Republican Natural Resources District."
[308] Interview with Upper Republican NRD.
[309] Upper Republican Natural Resources District, "Groundwater Management Rules and Regulations;" Interview with Upper Republican NRD.

9. FINDINGS

A few key themes arise across all three case studies, which prove to be instrumental in the successful management of water banks and water markets. These themes include: the importance of defined property rights, collaborative governance and stakeholder engagement, considerations for designing water banking and marketing institutions, and other water management strategies employed in each state. Each case offers a unique lens through which to explore these themes due to the statutory, political and hydrologic conditions in each state.

9.1 Defined Property Rights

The Colorado and Idaho case studies both highlight the importance of clearly defined property rights to the success of water banking and water marketing programs in each case. The importance of adjudication is emphasized, along with the benefit of securing high quality and comprehensive datasets.

ADJUDICATION CREATES EFFICIENCIES

All interviewees at the Idaho Department of Water Resources (IDWR) acknowledge the importance of adjudication, even in basins that are not closed. All claims to water rights are settled once they have been adjudicated. This helps streamline water resource administration aspects like the management of delivery calls or adherence to minimum streamflow.

ADJUDICATING CREATES MARKETS

Statewide adjudication of all water rights in Colorado was mandated by the General Assembly in 1919, and procedures were further clarified by the Water Right Determination and Administration Act of 1969. As a result, Colorado Division of Water Resources (DWR) maintains a comprehensive database of consumptive uses within the state, and its hydrographic modeling systems are highly efficient. Therefore, property rights are well-defined and protected, which, in conjunction with the regulated marketplace sustained by the water court system, enables the functioning of a deep and active market for water rights throughout the state without requiring substantial monitoring or regulation.

DATA COLLECTION IS VITAL TO CONJUNCTIVE ADMINISTRATION

Idaho has established an extensive network of groundwater monitoring wells throughout the Snake River Basin partly as a result of the settlement agreements. These monitoring wells are used to gather data to input into the state's models and carefully track its aquifer levels. The ability to effectively map underground water gives the Idaho Department of Water Resources (IDWR) an accurate measure of water supply and a better understanding of how and where the

aquifer feeds into surface flows and vice versa. On several occasions, we heard from IDWR staff that the rigor of its groundwater modeling and data collection efforts is an important tool in properly administering conjunctive management in the state.

The groundwater models were an essential tool in projecting and validating the success of the provisions of the Surface Water Coalition - Idaho Ground Water Appropriations, Inc. (SWC-IGWA) Settlement Agreement. As such, the state is investing in developing an accurate model in the Treasure Valley in preparation for greater water scarcity projected in the future.

9.2 Collaborative Governance and Stakeholder Engagement

Due to the often substantial and varied constraints placed on water rights transfers by the conditions of place, kind, and time of use, effective management practices are most successful when they seek to maximize the integration of local knowledge and resources without incurring burdensome top-down control mechanisms. All three case study states contain positive examples of methods of inclusive governance. The success of these programs suggests the necessity of developing social capital assets for successful water rights management in order to discourage litigation and promote valuable information-sharing.

BRINGING EVERYONE TO THE (ROUND)TABLE

Water supply planning and policy is increasingly given over by the state to collaborative roundtable entities composed of right holders and other stakeholders within each basin created by the Colorado Water for the 21st Century Act of 2005. These committees meet regularly (and publicly) and strive to maintain consistent membership and leadership. Roundtables operate on a system of consensus-driven decision-making. As a result, early responsibilities were limited to the assignment of grant funding from the state to local water projects. However, after nearly a decade of positive results, roundtables were directed in 2014 to produce Basin Implementation Plans (BIPs) to explicitly identify water supply gaps in their regions and define workable strategies to meet these needs. These BIPs have been used over the past several years to steer policymaking at the state level. Critically, interviewees emphasized the importance of an iterative approach to collaborative governance, as state actors train stakeholders to provide consistent and accurate data and stakeholders establish sustained channels of communication with state actors. Initial BIP results were positive but did generate inconsistencies between basins, therefore the Colorado Water Conservation Board (CWCB) has tailored the forthcoming technical supplement to the statewide planning document to provide feedback and resources for the roundtables to improve the next round of BIPs scheduled for the next decade. The 21st Century Act also created an Interbasin Compact Committee (IBCC) in order to facilitate sharing

of information and resources between basins and to assist regulation of the high volume of interbasin transfers within the state. It cannot be overstated how important our interview subjects viewed the social capital generated by this process to the future of water supply and water rights in the face of overappropriation and climate change.

The success of the roundtables has also generated notable secondary effects (anecdotal but logical consequences of collaborative governance):

- Information-sharing among historically antagonistic stakeholders has improved market information and price signaling within the broader water rights market
- Improved public engagement on water rights issues and water supply management
- Improved trust in state oversight and decision-making process

KEEPING IT LOCAL

Although statutorily all Natural Resources Districts (NRDs) have the same array of tools at their disposal to manage groundwater resources (allocations, well drilling moratoria, flow meters, water use reports, land occupation taxes), each NRD employs a unique combination of these tools. NRDs allow transfers of groundwater rights, the mechanics of which differ depending on management tools—some NRDs allow trading of allocations (volumetric-based) while others allow trading of certified irrigated acres (area-based).

The local nature of groundwater management in Nebraska allows for flexibility in creating rules and regulations that are tailored to local hydro-geological and socio-political conditions. Nebraska's NRDs in the western part of the state consist of primarily rural agricultural counties with relatively small populations. This makes engagement with stakeholders easier than in more populous places due to the nature of tight-knit rural communities as well as geographical proximity and access to the regulatory agency, although agency officials still commonly cite landowner education as a challenge. Additionally, NRDs are governed by locally elected boards, affording residents more control over the management of their own groundwater resources. Local boards commonly include local groundwater irrigators which gives NRDs more credibility with other farmers in the community, allowing NRDs to impose regulations and enforcements that may otherwise be politically unpopular or even infeasible. NRD staff also cite the importance of keeping local control of groundwater rules and regulations to the greatest extent possible.

NEGOTIATED PATH TO CONSENSUS

Idaho's settlement agreements have been highly consequential in Idaho, and their achievement has in part been a response to the overwhelming political pressures to negotiate a positive outcome. Indicative of the authority needed to reach a negotiated resolution, the State's Governor and Attorney General were principals in the negotiation of the Swan Falls Agreement in 1984 and the Speaker of the House was the mediator of the first Surface Water Coalition - Idaho Ground Water Appropriations, Inc. (SWC-IGWA) Settlement Agreement in 2015.

Idaho's settlement agreements also illustrate that the state can be a partner in facilitating a bargain between willing parties. It's important to note that SWC and IGWA were very motivated to reach a settlement because of the consequences that each group faced. The agreement was forged in the crisis that arose from the projection that severe delivery calls were expected if the status quo remained.

9.3 Institutional Design Considerations

Each case study outlines formal water banking and marketing institutions that help to facilitate the success of water banking and water marketing programs in each state. In Idaho, the introduction of fees allows for additional resources to accommodate system growth while having no discernable impact on demand in subsequent years. In Colorado, the district water courts generate extensive market information while limiting the use of the judiciary as a lawmaking body. Finally, in Nebraska the details of regulatory structures are important in facilitating the development and management of healthy and well-functioning water markets.

FEES FOR SERVICE

In 2010, the Idaho Water Resource Board (IWRB) implemented a rule to charge a filing fee for Water Supply Bank lease applications largely in an effort to financially support investing more resources in accommodating the burgeoning demand that followed the Snake River Basin Adjudication. After internal deliberation, the department determined it would charge $250 per water right based on what it charged for filing other applications. Perhaps somewhat surprisingly, despite implementing a fee, Idaho Department of Water Resources (IDWR) saw steady growth in every year after implementing the fee in 2010, until 2015, where it has leveled off. IDWR projects that the growth will continue once again as the rest of the state is adjudicated. The department is considering charging a fee for rentals as well, but it has yet to do so.

The filing fee does not make the Bank self-sufficient, however. The state still sees the program as a public service; the fee was never intended to fully compensate the program costs. Although, IDWR is considering rate structures to articulate the true cost of the program.

STREAMLINED LEGAL STRUCTURE FOR WATER MARKETING

Colorado is home to a regulated private market for water rights that is unique in the United States. The presence of district water courts has provided buyers and sellers with an authoritative mechanism for evaluating and approving water rights transfers. Transparency is critical to the process, and the public nature of court proceedings has generated extensive market information and limited the administrative burden of adjudicating secondary effects and injury due to transfers. Moreover, maintaining a dedicated judicial division for water rights issues has limited the use of the judiciary as a lawmaking body by placing adjudicative authority in the hands of water law experts, while the standing Supreme Court Water Committee sustains an open channel between local and state legal authorities regarding the consistent and appropriate application of water law.

IMPORTANCE OF REGULATORY DETAILS

In Nebraska, the management tools used combined with specific rules governing transfers dictate the way a market for groundwater trading can function in each Natural Resources District (NRD) and the amount of market participation and activity. In their transfer rules, NRDs take the Stream Depletion Factors of the location of origin versus the location of transfer into account, resulting in a ratio-based trading system of rights. Other transfer considerations include limitations on how far water users can transfer their rights using transfer limitation zones or floating townships, and downstream to upstream transfers. However, each NRD's specific restrictions vary.

Although much of the water rights trading in Nebraska is done through informal means where buyers and sellers connect via word of mouth, there have also been formal market systems set up by private and public entities. These systems include electronic smart markets that take a NRD's rules and regulations into account to match buyers and sellers as well as an incentive program that pays farmers to voluntarily stop irrigating and then allows them to buy and sell water credits. The success of these programs in achieving their goals has been mixed and largely depends on the specific transfer rules and regulations that have been set up by the NRD, emphasizing the importance of structural regulatory details.

9.4 Other Water Management Strategies

The Idaho and Colorado case studies demonstrate alternative water management strategies that are used to create functioning markets. Alternatives include Colorado's water court system, shareholder water bank, and Idaho's settlement agreements.

WATER COURT SYSTEM

Each of the seven district water courts, created via the Water Right Determination and Administration Act of 1969, are overseen by a water judge appointed by the Colorado Supreme Court and staffed by a Department of Water Resources (DWR) engineer, a court-appointed water referee, and a water clerk. All applications for new appropriations, change of water right use or place, water right transfers, and curtailment calls must be submitted to the water court for evaluation and approval. The statutory authority under which water courts operate guarantee consistent and expert application of water right administration throughout the state. Additionally, all applications are published for public comment at their time of their submission, creating an extensive public record of water market activity. Moreover, third parties seeking to claim injury due to new or altered appropriations must submit official objections during the evaluation process, dramatically limiting the scope and expense of water rights-related litigation.

SETTLEMENT AGREEMENTS

There is a lot of optimism that the Surface Water Coalition - Idaho Ground Water Appropriations, Inc. (SWC-IGWA) Settlement Agreement can be a long-term solution to the persistent problems in Idaho's Eastern Snake Plain Aquifer (ESPA). While the settlements took a lot of time and cost the department a great deal of time and resources in support of the negotiations, the ends seem to have justified the means. To date, junior groundwater pumps have made substantive reductions to water consumption while the Idaho Water Resource Board (IWRB) has exceeded its aquifer recharge targets for three consecutive years. Because of the safe harbor provision, junior groundwater users participating in the Agreement have not been subjected to delivery calls by the senior SWC members, a reprieve from what likely would have been a yearly occurrence with the Idaho Department of Water Resources' more stringent methodology for determining conjunctive impairment.

SHAREHOLDER WATER BANK

Major interbasin transfer operations disburse water supplies through a shareholder process. At the inception of each project (reservation of an absolute or conditional diversion, usually but not always operating from a surface reservoir), interested parties in the disbursement region are

allowed to purchase shares of the project's annual release. Each year the controlling entity of the project (typically a water conservation district) assesses the water supply available to the project and defines the release volume for each share as a percent maximum. Shares can be purchased or leased freely in an unregulated market within the disbursement region. Any surplus water available to the system (in the case of a reservoir project) is then placed in a rental pool for auction within the disbursement region. This system works best in cases where the controlling entity is able to own return flows from shareholder use (as is the case in interbasin transfers) so that place of use can be freely changed within the disbursement region. As a result of this system, the underlying water right generating the water bank is not subject to any alteration through the operation of the bank or changes in the composition of water consumers.

10. CONCLUSION

Ecology commissioned this study in part to inform their future direction in water management. We conducted a high-level overview of the context around water banking and water marketing in all Western states with a prior appropriation system of water rights governance. Colorado, Idaho and Nebraska were selected as case studies both for their similarity to state-level legal frameworks in Washington, and also to maximize variation across two primary criteria: user characteristics and management type. We reviewed the existing literature on water banking and water marketing to obtain information related to water banking and marketing broadly, as well as to obtain information specific to water banking and water marketing in Colorado, Idaho and Nebraska. Additionally, we conducted semi-structured phone interviews with individuals involved in water banking and water marketing in our case study states as well as individuals involved with water banking and water marketing more broadly. This report provides an overview of water banking and water marketing derived from the literature before diving into the three case studies: Colorado, Idaho and Nebraska. Each case study examines relevant statutory and regulatory considerations, outlines existing and proposed water banks and water markets, and discusses the relevant market mechanisms utilized in the operation of water banks and water markets.

Our findings relate to a few key themes that arose in each case study: clearly defined property rights, collaborative governance and stakeholder engagement, institutional design considerations, and other water management strategies. Each case study offered a unique lens through which to explore the relevance and importance of these themes in the administration of healthy water banks and water markets due to the specific statutory, political and hydrologic conditions in each state.

11. APPENDICES

11.1 Stakeholder Interviews

Interviewee	**Organization**
General	
Tony Willardson, Executive Director	Western States Water Council
Colorado	
Linda Bassi	Colorado Water Conservation Board
Barbara Biggs, General Manager	Roxborough Water and Sanitation District
Jaclyn Brown, Water and Natural Resource Policy Advisor	Tri-State Generation & Transmission Association
Greg Johnson	Colorado Water Conservation Board
Kevin Rein, Colorado State Engineer	Colorado Division of Water Resources
Cleave Simpson, General Manager	Rio Grande Water Conservation District
Brad Wind, General Manager	Northern Colorado Water Conservancy District

Interviewee	**Organization**
Idaho	
Remington Buyer, Water Supply Bank Coordinator	Idaho Department of Water Resources
Amy Cassel, Water Transactions Program Manager	Idaho Department of Water Resources
Shelley Keen, Water Allocation Bureau Chief	Idaho Department of Water Resources
Bill Kramber, Senior Remote Sensing Analyst	Idaho Department of Water Resources
Brian Patton, Planning and Projects Bureau Chief	Idaho Department of Water Resources
Jerry Rigby, Former Chair	Western States Water Council
David Tuthill, Founder	Idaho Water Engineering
Sean Vincent, Hydrology Section Manager	Idaho Department of Water Resources

Interviewee	**Organization**
Mathew Weaver, Deputy Director,	Idaho Department of Water Resources
Nebraska	
David Aiken, Professor	University of Nebraska-Lincoln
Jesse Bradley, Assistant Director	Nebraska Department of Natural Resources
Nick Brozovic, Director of Policy	Water for Food Daugherty Global Institute, University of Nebraska
Ann Dimmitt, Integrated Management Plan Manager	Twin Platte Natural Resources District
Jasper Fanning, General Manager	Upper Republican Natural Resources District
Rod Horn, General Manager	South Platte Natural Resources District
Nate Jenkins, Assistant Manager	Upper Republican Natural Resources District
George Oamek, Economist	Platte River Recovery and Implementation Program

Interviewee	**Organization**
Anthony Schutz, Professor	University of Nebraska-Lincoln
Mike Thompson, Permits and Registrations Division Head	Nebraska Department of Natural Resources
John Thorburn, General Manager	Tri-Basin Natural Resources District
Lyndon Vogt, General Manager	Central Platte Natural Resources District
Richael Young, Co-Founder	Mammoth Trading

11.2 Interview Questions

1. What does water banking mean in your state?

2. Can you describe your role with [organization name] as it relates to water banking?

    a. (If not described above) What role does your organization play in the development and management of water banks?

3. Why was (were) the water bank(s) created?

4. Describe the marketplace.
    a. How does your water market operate?
    b. How do participants access the market and market information?
    c. What specific mechanisms (e.g. auction, clearinghouse, deposit, etc.) does (do) the water bank(s) use?

5. How was the water bank(s) implemented?

6. What challenges have you faced in the development and management of water banks?

7. (If not described above) How have you responded to these challenges?

8. Does your organization have an overarching strategy to the development of water banks?

9. How have you coordinated with relevant stakeholders (tribes, senior water rights holders, developers, etc.) in the development or management of water banks?
    a. Mandated coordination?

10. What have we not asked that you think is important we know?

11. Who else should we talk to?

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